United States
Department of
Agriculture

Forest Service

**Pacific
Northwest
Region**

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By Clinton K. Williams, Area Ecologist
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INTRODUCTION

"Management of natural resources on range and forested lands has become increasingly critical as a result of greater resource needs and increased public awareness. Nowhere is this more evident than in the management of public lands (Public Land Law Review Commission, 1970). Hall (1967) states that management of non-arable lands (forest and rangelands) is primarily concerned with deriving products from the natural vegetation; and as resource management intensifies, knowledge about vegetation must increase." (Williams, 1978).

The recurrence of similar plant assemblages across a forest can be used to stratify the landscape (Daubenmire and Daubenmire, 1968; Pfister and others, 1977). The vegetation, soils and physical characteristics can usefully indicate plant responses to management, productive potential and future species composition of a site. However, not all questions about a piece of land can be answered by a plant community classification (Hemstrom and others, 1982).

Classification of plant associations allows us to:

1. Plan management strategies -- evaluate resource condition, productivity, and responses to manipulation.

2. Communicate -- record successes or failures of management actions, provide a common description of forest conditions for various disciplines.

3. Apply research -- provide a direct link between research results and practical land management.

Facing increased public awareness and resource demands on lands under their administration, the forest supervisors of the Okanogan, Colville and Wenatchee National Forest recognized a need for more resource information upon which to base some land management decisions. Consequently, studies of the plant communities of the three forests were initiated in 1975.

The objectives of this project are to (1) develop a vegetation type classification based on relatively stable plant communities; (2) collect adequate data to characterize the physical attributes of each type, including soils, slope, aspect, microrelief and landform; (3) determine and present estimates of site productivity; and (4) document the effects of disturbance and make management recommendations.

Because utilitarian administrative needs are the impetus for the work, some assumptions and areas of emphasis differ from similar work done by universities or research agencies. Because time, monies and staffing are limiting, the following priorities were established:

1. Work will concentrate where management impacts and concerns are the greatest. This means that initial work of classification is mainly in commercial forest land and that non-forest areas will be studied after forested areas are completed. Wilderness areas are not intensively sampled at this stage of the study.

2. Tree productivity estimates by plant community are needed. Therefore much of the sampling is time and labor demanding.

3. Classification units must be identifiable by field personnel with a minimum of training.

4. Classification units will be formed only when there is enough difference in management interpretations or environmental conditions to warrant the creation of a new unit. Floristic differences alone are not normally sufficient reason to create a new association.

This report deals only with the forested plant communities of the Okanogan National Forest. Work is still proceeding in other parts of the three forests in Planning Area II.

CLASSIFICATION CONCEPTS

The purpose of plant community classification is to reduce a potentially infinite number of communities or stands into classes or "types" (groups) that can be more easily comprehended. Individual members of types should be more similar to each other than they are to members of other classes. The development of types provides a "pigeon hole" into which information applicable to all members of the type can be placed. Thus the classification in this guide should be viewed as an information storage and retrieval system.

The development of classes or types involves an abstraction from reality. The stands we sampled are real entities, but grouping them into a class or type places them into an abstract conceptual framework. Since classes are abstractions, a variety of different types of classifications are possible. As the purposes of classification change, so may the classification.

The major purpose for developing the forested plant community classification for the Okanogan National Forest is to aid land managers in making decisions related to the vegetation resource. Thus, management considerations have been used when appropriate to help delineate groups or classes.

Plant ecologists endlessly argue the relative merits of the "continuum" concept versus the "discreet community" concept expoused by others. The whole argument is useless for land managers. They must still manage the acres in question, and these acres are most easily treated in discreet units. Therefore, we have sampled with the attitude that even if a continuum in vegetation exists, it must still be subdivided into portions (types) to make it comprehensible.

FIELD METHODS

Due to the size of the area; it was first sampled using a reconnaissance technique. This sampling developed familiarity with vegetation patterns and variability and was used to develop a preliminary plant community classification. The reconnaissance level classification was used as a stratification upon which to plan intensive sampling.

Reconnaissance sampling methods are adapted from Franklin and others (1970), Pfister and others, (1977) and Williams (1978). Plot size is from Pfister and others and is a 375 meter square circular plot.

Plots were selected "subjectively without preconceived bias" (Mueller-Dombois and Ellenberg, 1974). Plots were located within homogenous stands with uniform undergrowth, and apparent lack of recent disturbance. Random or systematic sampling techniques were rejected as too time consuming and inefficient. Most plots are located near roads to reduce travel time and are marked with aluminum tags to aid relocation.

Data taken on reconnaissance plots included physical information such as slope, aspect, elevation, slope position and shape, and location. A species list was made within the circular plot and foliar cover estimated for herbs, shrubs, tree understory and tree overstory by species. Foliar cover was estimated to the nearest 1% for values under 10% and to the nearest 5% for values above 10%. Tree information is further subdivided into mature and decadent categories in the tree overstory, and pole and young trees in the understory. Specific criteria for each category were employed.

Plots representative of the variation within each association and throughout its geographic range were selected for revisiting. The reason for this was not to necessarily revisit a specific plot but to efficiently sample the range of characteristics, locations and conditions of a given association. The reconnaissance plot informed the team leader that vegetation representative of a specific association was in a general area. If the old reconnaissance plot could not be quickly located, another suitable stand in the locale was substituted. Additionally, the intensive sampling crew was not held to a preconceived sample location. If stands suitable for sampling were encountered, the crew was flexible to install plots as judgement and experience indicated.

Data gathered on intensive sample plots included all that taken on reconnaissance plots plus measurements of tree height, diameter at breast height, basal areas, sapwood width, and growth rates for five individuals of each tree species in the stand (if possible). Stand basal areas were measured and herbage production determined. Rooted frequency was taken on some plots. Each intensive plot also had a soil pit dug near the plot center and complete SCS soil profile description taken. Notes on fire scars, wildlife observations and general stand conditions are made.

Floristic data were taken using the same size plot as the reconnaissance work. But tree data were based on dimensionless plot techniques. All trees had to be within the specific plant association the plot was designed to sample. The plant ecologist made this judgement based upon his familiarity with the vegetation.

OFFICE METHODS

Reconnaissance floristic data were taken in 1975 and 1976 along with some environmental observations. These data were used to develop a tentative classification. The reconnaissance level classification was used as a stratification upon which to plan intensive sampling. The bulk of the intensive sampling took place in 1981 but a few plots were sampled in 1982.

Data were entered on a computer at the end of each field season and analyzed. Computer programs used in data analysis included synthesis tables, similarity index, cluster analysis, and discriminant anaysis (Volland and Connelly, 1978). Synthesis tables and discriminant analysis received the greatest emphasis. Synthesis tables were used to form tentative associations and were tested and refined with discriminant analysis.

A total of 357 reconnaissance and 223 intensive plots were taken and used to develop the classification in this guide. Floristic data in the tables are based on both reconnaissance and intensive plots. Soils and productivity data are from intensive plots only.

In tables the term mean indicates the arithmetic average for a species of all occurences. Constancy is the percentage occurrance of a species in the plots used to describe a particular association. For example, the mean of overstory PSME cover in the PIPO-PSME/AGIN association is 11%, and the constancy is 77%. These figures indicate that overstory PSME in the association has an average cover of 11% in the plots it was in; but it was found in only 77% of the plots used to typify the association. A constancy of 100% indicates a particular species occurred in every plot representative of the association.

Cover as presented in the tables refers to the percent foliar cover of a species in a plot. Each vegetation layer, tree overstory, tree understory, shrubs, and herbs were estimated independently of each other. Cover for all species in a particular layer rarely approached 100% because areas without living vegetation were not part of the estimate. Cover was not taken as a proportion of all vegetation. Each species was estimated independently of all others. Total cover in a stand can exceed 100%, summing all four layers. In the preceeding example 11% cover means that 11% of 100% cover in the tree overstory was made up by PSME.

From the intensive data the following indices were determined: Site Index to estimate height growth, Growth Basal Area (Hall, 1983) to estimate stockability, and Stand Density Index (Reineke, 1933) to estimate stand densities. Cubic feet per year productivity estimates were calculated using a combination of Site Index and Growth Basal Area for one estimate; the other was made using Stand Density Index as a percentage of normal in combination with species specific mean annual increment equations following instructions by Knapp, (1981). See Appendices G and H. Additionally, herbage was clipped and weighed to estimate herbage production.

All of these methods have limitations, but because they were applied consistently on each plot they provide a reasonable means of comparing one plot or association average with another.

We used the site index tables currently recommended in the Region 6 Timber Management manual. See Appendix F. Though many, if not all, of the tables appear to poorly fit our data; we chose to use the tables people on the Forest were currently using.

To determine site index we arbitrarily added 7 years to each breast height age for all species. With no local data to make individual species adjustments we used a single constant age.

Some base 50 scales had to be converted to base 100 scales to estimate cubic volume productivity using the equation (GBA/10 X SI/10 X .50) suggested by Hall (1983).

It is important to remember that these estimates of productivity for each plant association are merely relative estimates of site potential. Furthermore, a majority of the plots are from mixed species stands. The productivity estimate techniques are not well suited to stands with multiple species because of different responses to environmental and competition factors by species. This is especially a problem in the Stand Density Index estimates because a specific species growth equation was used for a stand as a whole, which may have contained nearly equal amounts of two or more species.

Comparison of productivity estimates based on Stand Density Index with those derived using Growth Basal Area and Site Index often shows a wide disparity in figures. Productivity data for species given in standard site index tables is usually lower than that given by Growth Basal Area and Site Index and below that given by Stand Density Index.

Appendix B lists the codes for productivity information used in tables and in Appendix E. Summary productivity information by association is presented in Appendix E.

A total of 357 reconnaissance and 223 intensive plots are the basis of the data in this guide. Just over 1,700,000 acres are administered by the Okanogan National Forest. Well over 500,000 acres of that amount are within wilderness and are not really part of the classified area. The sampling intensity approximates 500 plots per million acres. This is several times the 75 plots per million acres used for Montana as reported by Pfister and Arno (1980), and the 47 plots per million acres used in a recent study of central Idaho by Steele and others (1981).

CONCEPTS AND TERMINOLOGY

We use the climax community concept as defined by Tansley (1935). But a climax community is difficult to conclusively demonstrate on some sites. We do think it ecologically meaningful to use as part of the plant community name the tree(s) with the greatest shade tolerance (roughly equated with competitive ability) capable of consistently growing on a site. We also use the shrub or herb species that most typifies the undergrowth. Thus, the plant community name is suggestive of the major species on a site after a long period of undisturbed conditions. This postulated climax plant community we call the plant association. Whether or not this "climax" community will ever develop or not is immaterial. What is important is that the association name provides a stable end-point to plant succession (conceptually) and gives an indication of the direction of succession in closed stand conditions.

Naming conventions of associations and species are as follows. A slash (/) separates members of different life forms (trees, shrubs, herbs), and a dash (-) separates members of the same life form. Most association names are restricted to two major species for ease in use. We recognize that not as much information about important species is presented in a short name, but feel that convenience in use more than makes up for loss of information. Experience in use of association names indicates that users often shorten long names in usage so longer names are of doubtful utility. Some longer names (three species) have been retained as needed to avoid ambiguity.

Plant associations are referred to in the text and tables by codes formed by taking the first two letters of each scientific name of a species. Therefore the code for Pseudotsuga menziesii is PSME based on the scientific name. The code is used because it is shorter to write and say than are the full common or scientific names and is better adapted to computer use. All codes follow Garrison and others (1976). All codes, common, and scientific names are given in Appendix A. Scientific names follow Hitchcock and Cronquist (1973). Common names follow Garrison and others (1976) and Hitchcock and Cronquist (1973).

We realize this is a unique approach but have noted that conversation of ecologists is replete with phonetic vebalizations of the codes. The codes are used in many management activities; i.e., the TRI System of Region 6 of the U.S. Forest Service, and many of the potential users of the guide (field personnel) were equally unfamiliar with common names, scientific names and codes. In the dawn of the age of intensified computer use in Forest Service management, codes appear to be the most useful form of nomenclature.

The variety name of some species is employed if it can be consistently identified and provides useful information. The most important example is the awnless variety inerme of the widespread species Agropyron spicatum (AGSP). In our area the awnless variety is present and awned variety is uncommon. We refer to it simply as AGIN because the distinction is consistent in our material. Other species that have only a single variety in the Pacific Northwest such as CHUMO and LIBOL are used as a matter of habit if not consistency.

Pfister and others (1977) indicate that most of the Picea trees in their area are a hybrid complex of Picea engelman-nii and Picea glauca . The same pattern may be true in our area but we took no cone scale data to prove or disprove possible hybridization. Our material keys easily to Picea engelmannii so we refer to all Picea in our data simply as PIEN.

For convenience we refer to associations capable of supporting a given climax tree species (under the preceeding definition) as a series. This concept is useful though it may not always be accurate. It is meaningful to discuss the PSME series as distinct from the ABLA2 series because of important differences in the environments encompassed by each. The ABLA2 series is cooler and/or more moist than the PSME series. Timber productivity is normally much higher in members of the ABLA2 series but herbaceous production is generally higher in the PSME series.

THE STUDY AREA

The Okanogan National Forest is located in north central Washington State (Figure 1), and administers approximately 1.7 million acres of land. This figure includes a western extension of the Rocky Mountains, the Okanogan Highlands, as well as parts of both eastern and western slopes of the North Cascade Range. Traditionally, the separation between the Okanogan Highlands and the east slopes of the North Cascades has been made along the Okanogan River. Ecologically, the separation line is farther west approximating the drainage divide between the Okanogan and Methow river systems.

Because of more obvious impacts and information needs, most work to date is within what has traditionally been commercial forest land. That portion of the forest west of the crest of the North Cascades and within the Pasayten Wilderness will be more intensively studied in the future.

TOPOGRAPHY

Glaciation has played a major role in shaping landforms in the area. The North Cascades were first glaciated by alpine glaciers. This area has steep slopes, U-shaped valleys, and rugged topography typical of alpine glaciation. Later a continental ice sheet covered all but the tops of the highest mountains in both the North Cascades and the Okanogan Highlands. The continental ice sheet did not greatly modify the basic shape of the alpine glaciation landforms typical of the North Cascades. It smoothed and rounded some summits and removed most depositional landforms left by the alpine glaciers; but deep U-shaped valleys between steep highly dissected ridges, cirques, long pointed peaks and knife-like ridges still remain. In the Okanogan Highlands alpine glaciation did not precede the continental ice sheet so the topography is typified by moderate slopes and broad rounded summits; in striking contrast with the rugged North Cascades.

CLIMATE

The climate on the forest varies from near steppe conditions east of the Cascades at Alta Coulee to a cool, moist maritime type with heavy snowfall along the Cascade crest. Climates with characteristics of both continental and maritime climates are found on the forest, often within relatively short distances of each other.

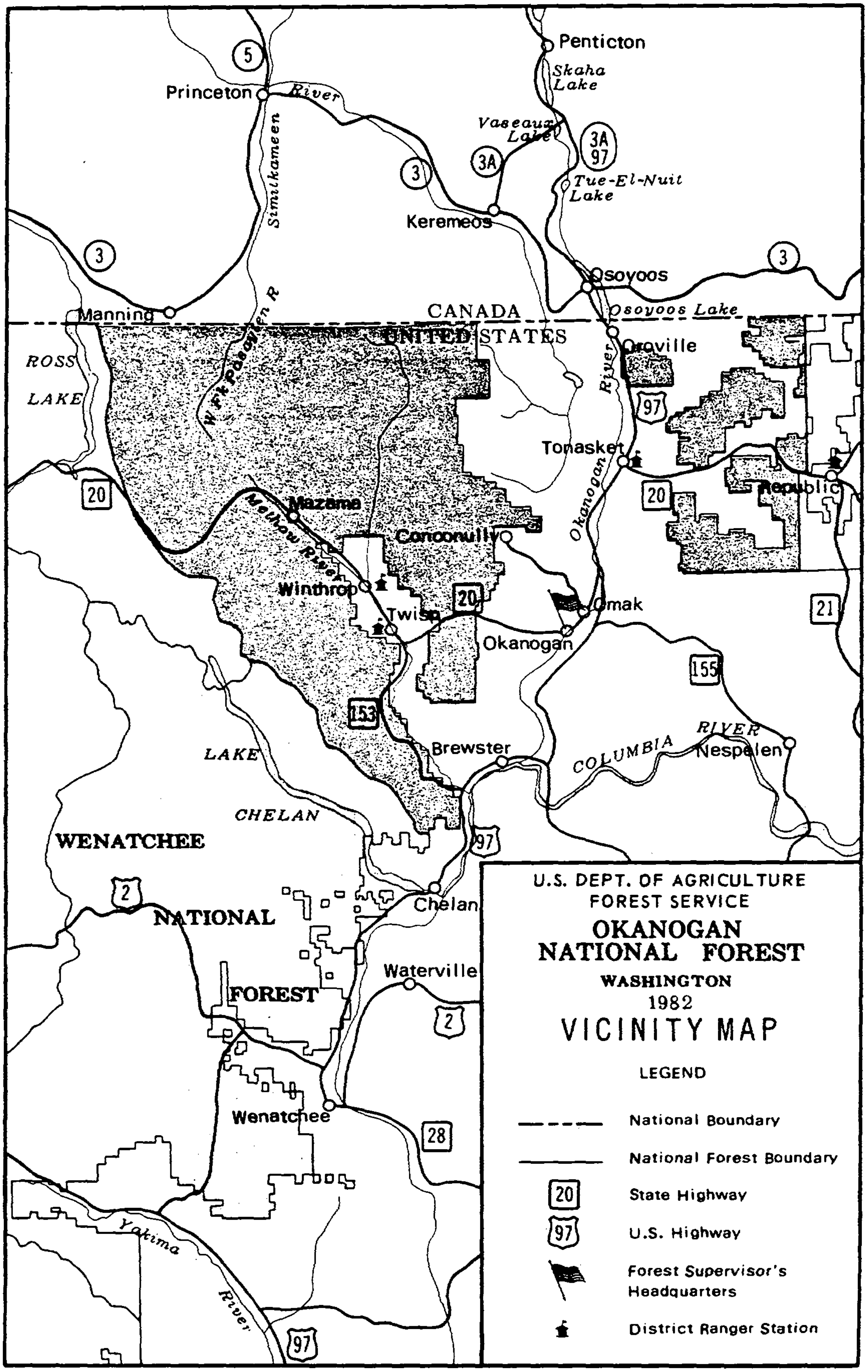
Normally, warm and moist maritime air moves eastward toward the Cascade crest. As the air climbs to cross the mountains, it cools and drops most of its moisture on the windward slopes. As the air descends the east slopes of the mountains, it warms by compression decreasing precipitation sharply, creating a rainshadow. The rainshadow is most strongly developed on the lower east slopes of the North Cascades and the effect is less on the Okanogan Highlands. Cold arctic air moving down north-south trending valleys occasionally disrupts the normal eastward movement of maritime air some winters. Precipitation varies from a low of near 10 inches at the lowest elevations to 160 inches or more in the North Cascades (Figure 2). Topography and distance from the ocean are major influences on local climatic patterns.

GEOLOGY

The accompnaying generalized geologic map (Figure 3), of the forest was developed as part of a broad soil inventory of the forest and gives an overview of the major geologic patterns in the area. Glacial drift, tills, and outwash often mask the underlying bedrock making local geology difficult to interpret.

For reasons of simplicity and convenience, all igneous intrusive rocks are lumped together and termed "granitic". This group includes quartz diorite, diorite, granite, granodiorite, and quartz monzonite. Metamorphic rocks of similar origin are also in this group and include gneisses and some hornblend. All extrusive igneous rocks are termed "volcanic" and include such diverse types as andesite, basalt, dacite, rhyolite, tuffs and flow breccias. The group of rocks termed "sedimentary" includes sandstone, siltstone, shale, arkose, conglomerate and limestone. Similar metamorphic rocks included in the group are marble, quartzite, argillite and slate.

Parent material of soils is important in some plant communities. Presence or absence of a measurable amount or layer of volcanic ash in the soil is important.



Penticton
Skaha Lake
Princeton
River
Similkameen
Vaseaux Lake
3A
97
3A
3
5
Tue-El-Nuit Lake
Keremeos
3
3
Osoyoos
Manning
CANADA
UNITED STATES
Osoyoos Lake
Oroville
ROSS LAKE
River
97
Tonasket
20
Okanogan
20
Republic
Mazama
Methow River
Conconully
Winthrop
Twisp
20
Omak
21
Okanogan
155
153
Brewster
COLUMBIA RIVER
Nespelen
LAKE
CHELAN
WENATCHEE
97
2
NATIONAL
Chelan
FOREST
Waterville
2
Wenatchee
28
Yakima River
97
U.S. DEPT. OF AGRICULTURE
FOREST SERVICE
OKANOGAN
NATIONAL FOREST
WASHINGTON
1982
VICINITY MAP
LEGEND
National Boundary
National Forest Boundary
20
State Highway
97
U.S. Highway
Forest Supervisor's Headquarters
District Ranger Station

Figure 1.

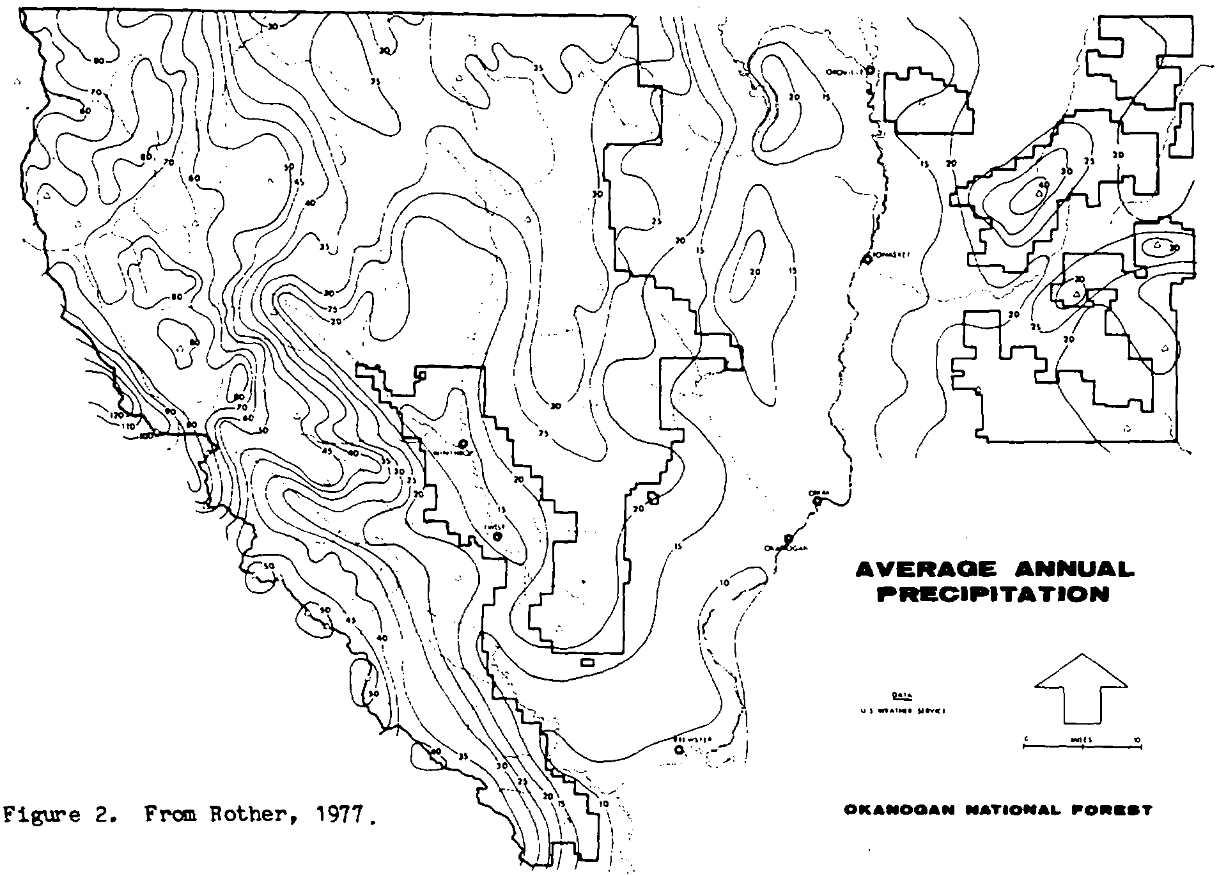


Figure 2. From Rother, 1977.

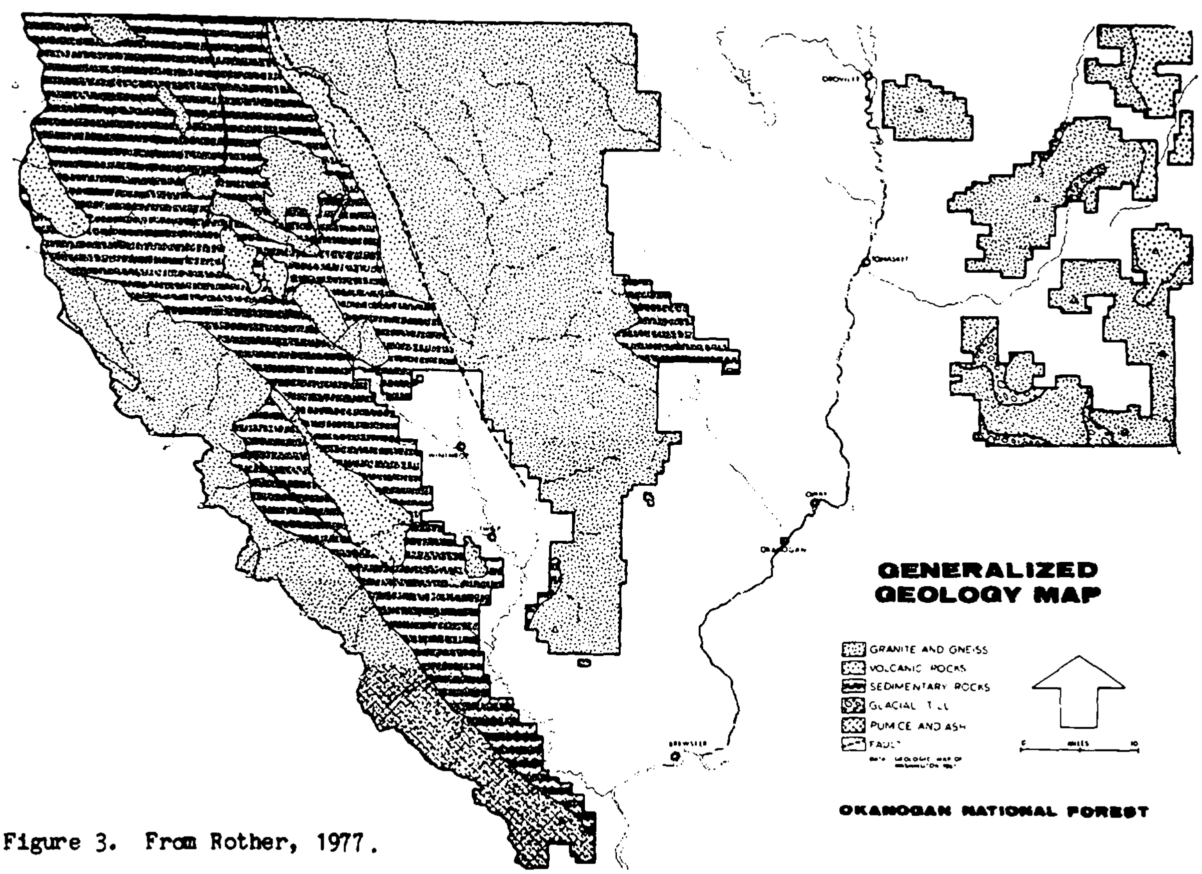


Figure 3. From Rother, 1977.

SOILS

Soils have developed from various parent materials, including granitic, volcanic and sedimentary rocks; glacial drift, pumice, ash, and alluvial deposits. These varied parent material sources, along with the effects of continental glaciation, have resulted in a complex array of soils.

Because of the short time since the last glaciation, dry climatic regime, steep topography, and slowly weatherable parent material, most soils are young. These soils include Xerochrepts, Cryochrepts, Haploxerolls and Cryoborolls. Often in coarse-loamy, coarse-sandy or even loamy or sandy skeletal families, reflecting the high coarse fragment percentages commonly found in glacial materials.

VEGETATION OVERVIEW

Vegetation patterns are different on the Okanogan National Forest than elsewhere in eastern Washington state. The tree species present and their ecologic roles when compared to other eastside forests show a distinctive pattern of forest development. See Table 1.

Table 1. Comparison of coniferous tree zones* of four eastern Washington National Forests. Only upland zones that occur as a closed forest are shown. (M) represents a zone of major importance; (s) a zone of secondary importance.

ZONE	NATIONAL FORESTS			
Species	Okanogan	Wenatchee	Colville	Umatilla
PIPE	s	M	s	s
PSME	M	M	M	M
ABGR		M	s	M
THPL			M	
TSHE	s	M	M	
ABAM	s	M		
TSME	s	M		
ABLA2	M	M	M	M
LALY	s	s		

* Zone is an area in which a single tree species is dominant per Franklin and Dyrness (1973). TSME is an exception, it being a major seral species. (Data for the Okanogan, Wenatchee and Colville National Forests are from fieldwork. Data from the Umatilla National Forest are from personal communication with Dr. F.C. Hall and applies only to that portion of the Forest within Washington state.)

Only PSME and ABLA2 form major upland closed forest zones on the Okanogan National Forest. The lack of more competitive trees allows these two species to dominate at climax a much greater percentage of the land than elsewhere in eastern Washington.

The eleven locally common tree species each have different autecologic characteristics, ecologic roles, and elevational distributions. See Figures 4, 5 and Table 2.

Tree species distributions on the Forest vary considerably. LAOC is not found west of the Methow-Okanogan divide, while LALY is not found east of the divide. ABAM and TSME are essentially restricted to the area near the Cascade crest, but they form continuous forest there. THPL is in some wet areas throughout the Forest but is more common near the Cascades. PIMO and TSHE are absent over most of the forest but become more common near the Cascade crest. They form only a small part of the forest tree stratum. ABGR is essentially absent from the Forest; only one small stand has been observed.

Shrub and herb distributions also vary from east to west on the Forest. PUTR and LUNA2 are largely restricted to the area west of the Methow-Okanogan divide within National Forest lands though PUTR extends well up into Canada in the Okanogan River Valley. Within the Forest boundaries it is rare east of the Okanogan River. PAMY is found throughout the Forest but has visibly greater stature and abundance west of the Methow River on some sites. PHMA reaches it's western range limits on the eastern edge of the Forest.

Some plant associations also have limited distributions. These are discussed in the individual association descriptions.

Of the twenty-four plant associations described in this guide; sixteen have names the same as those published by other authors. These association names are distinguished by the addition of the suffix OKAN (see Appendix C). For brevity elsewhere in the guide and tables, this suffix is omitted. Generally, associations of the same name by other authors do not characterize the same environments as encompassed by the associations on the Okanogan National Forest.

Figure 6 illustrates the development of frost prone areas following clearcutting. These patterns are important in the ecology of several plant associations and especially in management interpretations.

Table 3 compares the individual tree species and their successional status by plant association. Figure 7 is a schematic diagram of the associations on a moisture and temperature scale.

While all of these figures are idealized they are conceptually useful in understanding relationships of species to each other; one association to another; and their places within an environmental framework.

Table 4 gives the range or most commonly occurring values for soils and environmental information by plant association based on available plot data. Data do not reflect the full range of environmental conditions of some associations. For example: our plot data shows PIAL with a greater elevational extent than LALY. This is misleading

Table 2. Comparative autecological characteristics of conifer species. Data are compiled from various literature sources and field observations.

Species	Shade Tolerance	Frost Tolerance	Drought Tolerance	Snow Damage Resistance	Fire Resistance	Root Rot Resistance	Seed Weight	Seed Crop Frequency
ABAM	H 1/	M	L	M	L	L	H	M
ABLA2	H	M	M	H	L	M	M	M
LALY	L	H	L	H	L	M	L	L
LAOC	L	M	M	M	H	M	L	M
PIEN	M	H	M	H	L	M	L	M
PIAL	L	H	H	H	L		H	M
PICO	L	H	M		L	M	M	H
PIMO	M	H	M	M	M	M	M	H
PIPO	L	L	H	L	H	H	H	L
PSME	M	L	M	L	H	L	M	M
TSME	H	H	L	H	L	L	M	M
THPL	H	L	L		L	H	L	H

1/ H - high; M - moderate; L - low

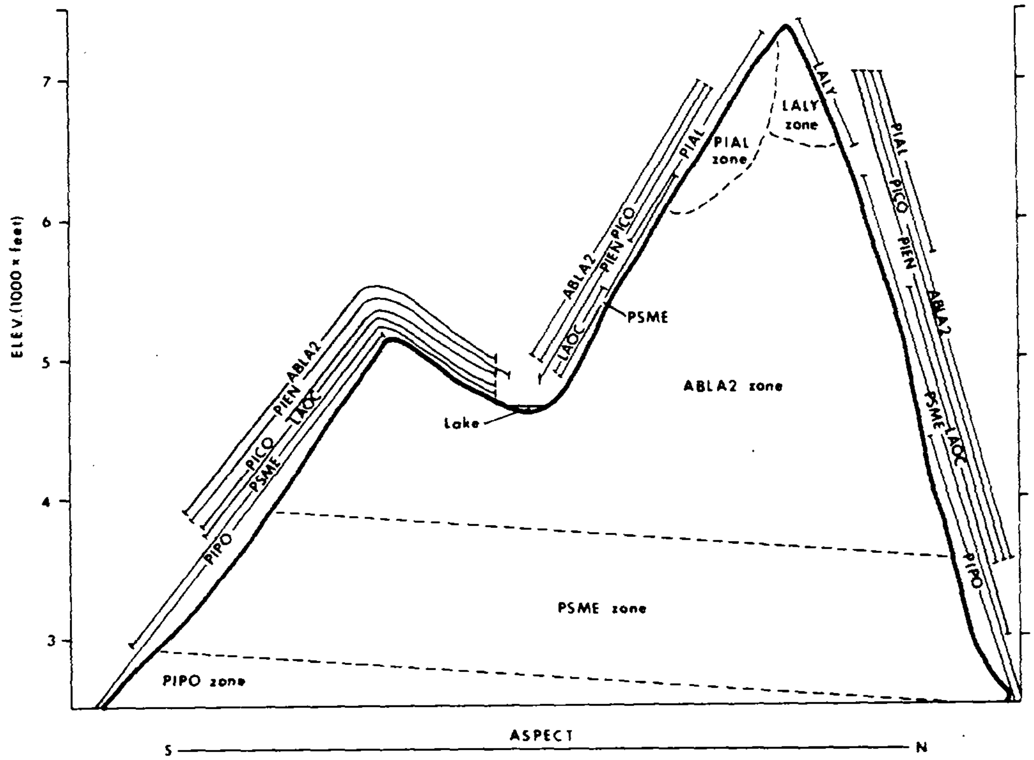


Figure 4. Distribution of important conifers on south and north facing slopes at different elevations on the Okanogan National Forest (modeled after Hemstrom and others, 1982).

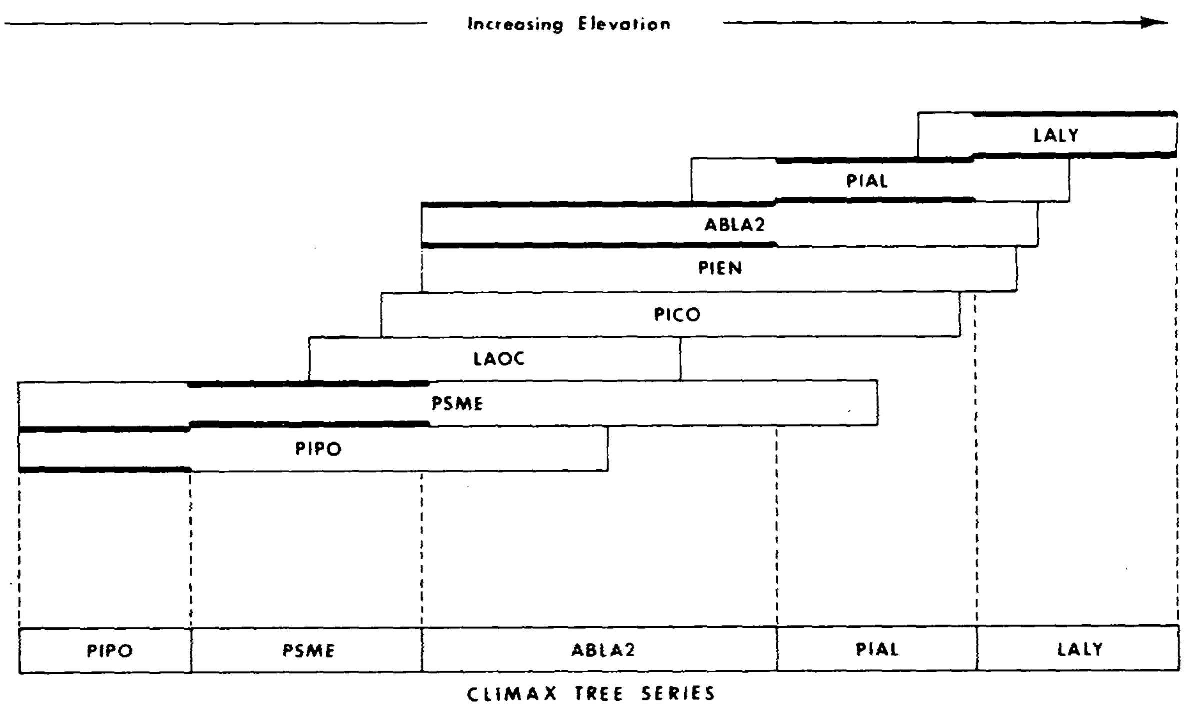


Figure 5. Schematic distribution of tree species usually encountered with increasing elevation in mature forest stands on the Okanogan National Forest. The area with heavy bars is that part of the range where a tree is competitively superior to its associates.

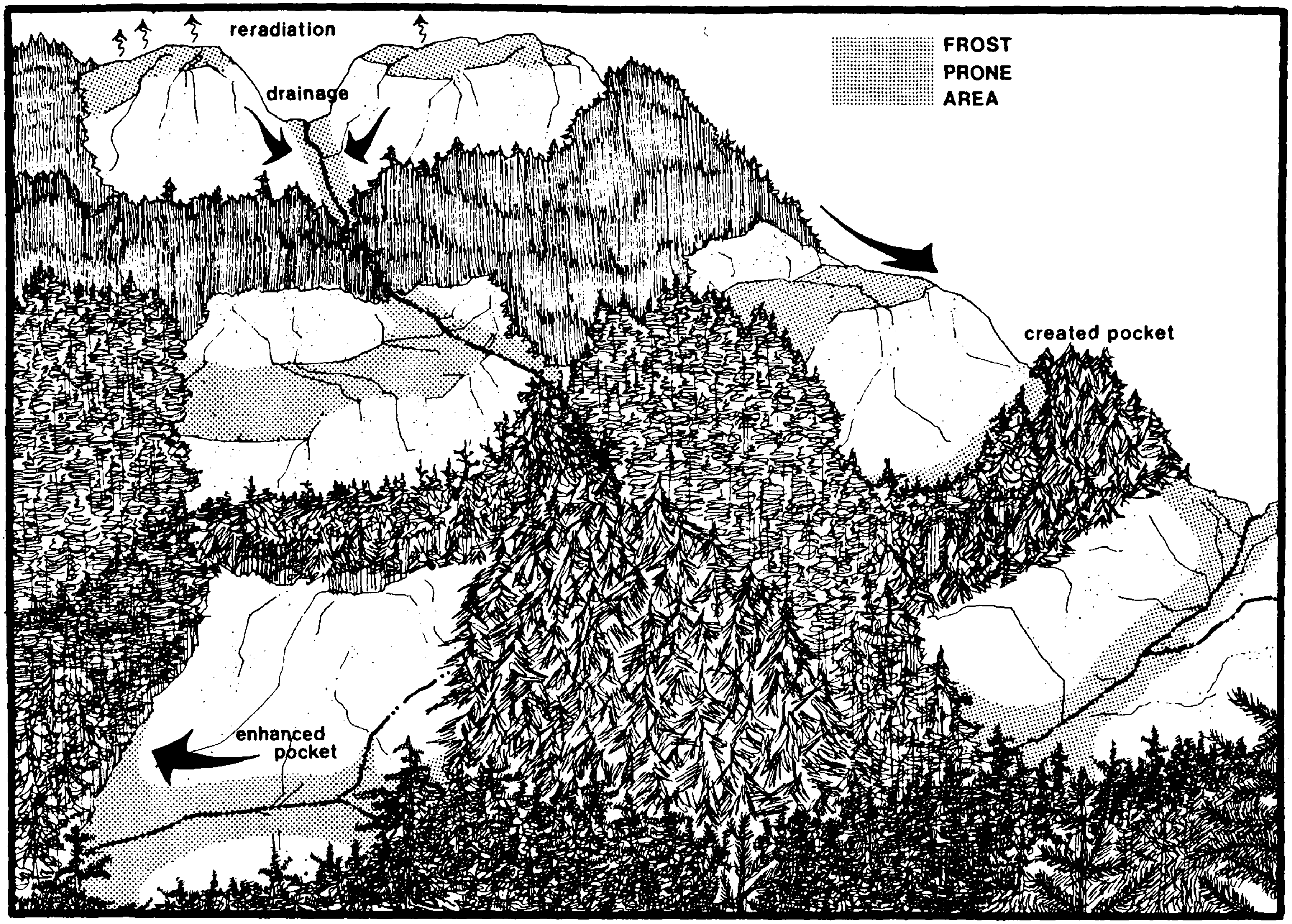


Figure 6. Development of frost prone areas in various topographic situations after clearcutting (from Hemstrom and others, 1982).

Table 3. Distribution and roles of tree species in relationship to plant association on the Okanogan National Forest

Distribution of tree species by plant association, showing their dynamic status C = major climax species; c = minor climax; s = seral; (s) = seral in certain areas of the type; a = accidentals as interpreted from the sample data. Table format is from Pfister and others, 1977.

Series	Plant Association	Tree Species										
		PIPO	PSME	LAOC	PICO	POTR	PIEN	ABLA2	PIAL	LALY	ABAM	TSME
	PIPO-PSME/AGIN	C	C									
	PSME/PUTR-ARUV	s	C	(s)	s							
	PSME/ARUV	s	C	(s)	s							
	PSME/CARU	s	C	(s)	s		a	a				
PSME	PSME/VACCI	s	C	(s)	s	s						
	PSME/SYAL	s	C			s						
	PSME/SYOR	s	C	(s)								
	PSME/PAMY	s	C			s		a				
	PSME/PHMA	s	C	s	s							
	ABLA2/VACCI	s	s	(s)	s	s	C	C				
	ABLA2/LIBOL	a	s	(s)	s	s	C	C				
	ABLA2/PAMY	s	s		s	s	c	C				
	ABLA2/VASC/CARU		s		s		s	C	s			
ABLA2	ABLA2/CARU	s	s	(s)	s		s	C	s			
	ABLA2/VASC				s		C	C	s			
	ABLA2/RHAL		s		s		c	C	s			
	PIEN/EQUIS		s	s	s	s	C	s				
	ABLA2/PHEM				s		C	C	s			
PIAL	PIAL/CARU		s		s		c	c	C			
ABAM	ABAM/PAMY						s	s			C	C
	ABAM/RHAL						s	s			C	C
POTR	POTR/CARU		a			C	a					
	POTR/SYAL		a			C	a					
LALY	LALY						c	c	c	C		

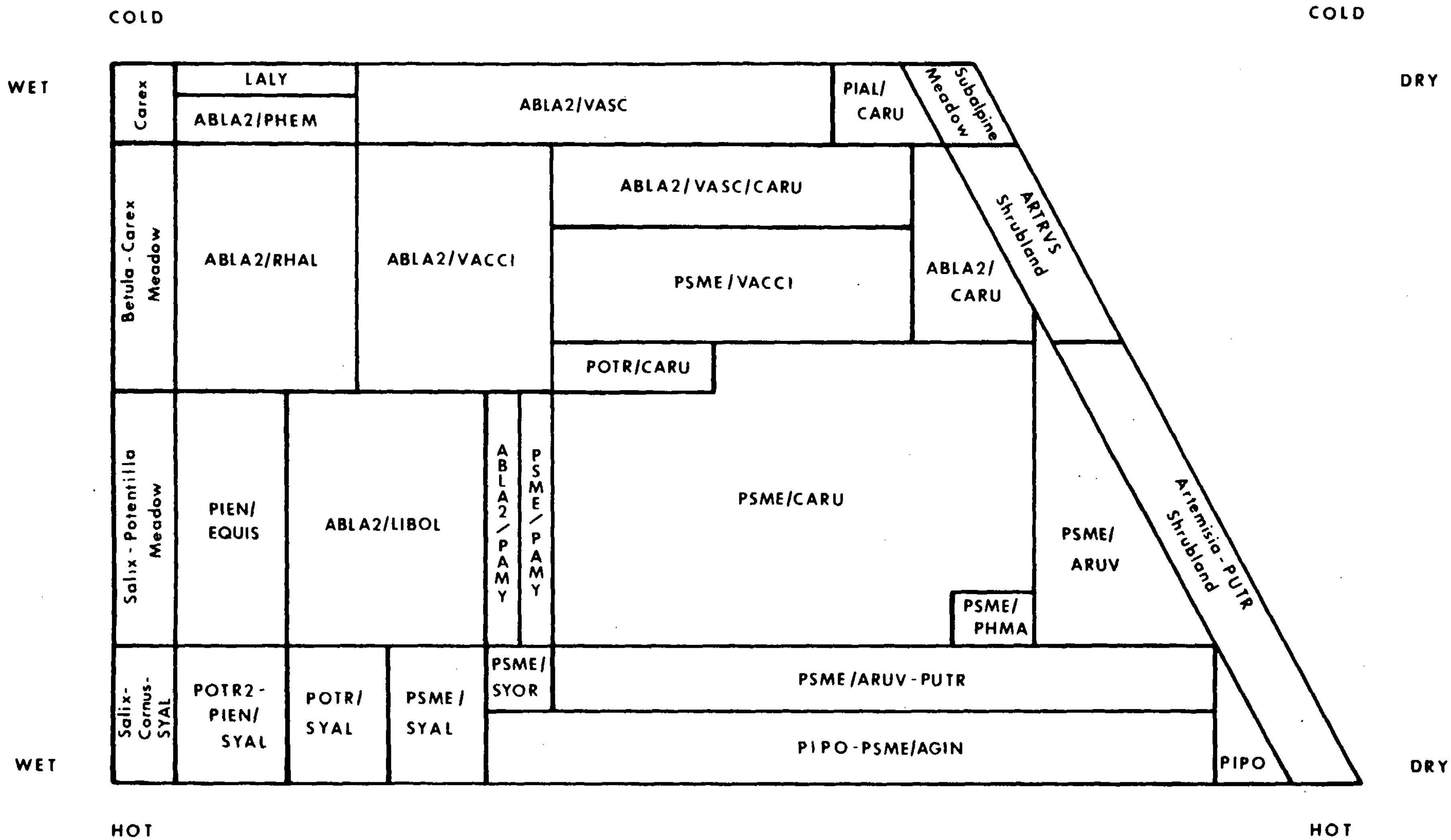


Figure 7. Relative relationships of forested plant associations and other vegetation zones to temperature and moisture gradients on the Okanogan National Forest.

Table 4: Range or most commonly occurring values for environmental and soils data by plant association.

Plant Association	Elevation	Aspect	% Slope	Slope Position	Pit Depth (inches)	Rooting Depth (inches)	% Coarse Fragments	% Surface Rock	Parent Material	Special
PIPO-PSME/AGIN	2460-4640 (3443)	S.E. to West (South)	12-68 (44)	Mid to upper 1/3 (Mid)	16-53 (34)	13-35 (23)	19-52 (40)	1-50 (9)	Granitic till or outwash	
PSME/ARUV-PUTR	2680-4800 (4156)	East to S.W. (South)	19-63 (41)	Midslope	16-40 (28)	10-28 (19)	23-45 (35)	0-35 (15)	Granitic till or outwash	Compacted subsoils
PSME/ARUV-OKAN	3960-5380 (4712)	East to West (South)	3-70 (34)	Ridgetops to midslopes	18-35 (26)	10-26 (19)	29-39 (35)	5-25 (13)	Granitic glacial outwash	Ash in many profiles
PSME/CARU-OKAN	2660-5290 (4521)	All	1-74 (35)	Mid to upper 1/3	10-62 (32)	10-46 (25)	19-56 (35)	1-20 (4)	Variable	
PSME/VACCI	3000-4860 (4240)	All	3-57 (22)	Midslope	20-38 (28)	14-35 (20)	11-41 (27)	0-5 (3)	Glacial till and outwash	Ash common in many soils
PSME/SYAL	2640-4200 (3315)	All	3-25 (16)	Mid to lower	24-33 (29)	24-30 (26)	6-52 (34)	1-2 (1)	Sedimentary till and outwash	
PSME/SYOR	2310-5240 (3622)	East to West (South)	30-68 (51)	Midslope	23-52 (36)	21-52 (32)	26-60 (42)	1-20 (8)	Variable	
PSME/PAMY	2400-4160 (2911)	All	6-65 (35)	Mid to lower 1/3	15-35 (28)	15-35 (24)	29-69 (43)	1-15 (5)	Sandstone alluvium	
PSME/PHMA-OKAN	2240-4040 (3005)	All	7-75 (41)	All	13-23 (19)	13-21 (18)	45-54 (49)	1-15 (9)	Variable	
ABLA2/VACCI	3480-5720 (4390)	All	1-38 (16)	Ridgetops and bottoms	20-58 (35)	15-50 (26)	6-37 (20)	0-3 (1)	Glacial till, outwash or alluvium	Ash in most soils
ABLA2/LIBOL	2170-5940 (4536)	All	1-59 (24)	Midslope and bottoms	12-50 (29)	10-36 20)	10-77 (35)	1-15 (2)	Glacial or fluvial	Ash common; sites variable
ABLA2/PAMY	2430-5200 (3336)	Northerly	3-61 (27)	Mid to lower 1/3	23-35 (31)	21-35 (27)	5-55 (33)	1-2 (1)	Sedimentary origin of glacial outwash	Ash absent
ABLA2/VASC/CARU	4960-5900 (5253)	East to West (South)	25-60 (42)	Ridgetop to lower 1/3	26-44 (33)	14-38 (23)	27-72 (42)	1-5 (3)	Sandstone to granitic outwash/till	Restrictive layer in soil
ABLA2/CARU-OKAN	4800-5740 (5316)	East to West (West)	25-60 (45)	Mid to upper 1/3	18-52 (34)	18-52 (28)	30-48 (39)	0-4 (2)	Sandstone-based outwash or till	Sandstone based soils
ABLA2/VASC	5500-6920 (6265)	All	3-65 (21)	Mid to upper	18-25 (21)	11-24 (16)	1-41 (29)	2-15 (6)	Granitic glacial till	
ABLA2/RHAL	4570-6310 (5742)	North	9-52 (29)	All	17-40 (29)	9-32 (19)	23-43 (33)	1-10 (2)	Glacial till or outwash	Soils moist to wet
PIEN/EQUIS	3550-4880 (4068)	All	1-44 (16)	Lower to bottoms	22-30 (26)	6-16 (11)	30-50 (40)	1-2 (1)	Till or alluvium	Perched watertable
ABLA2/PHEM	6700-7030 (6877)	North	10-35 (23)	Ridgetop to upper 1/3	No data	No data	No data	7-35 (19)	Granitic	Limited data
PIAL/CARU	5810-7340 (6625)	S.E. to West (South)	30-55 (42)	Ridgetop to upper 1/3	12 (12)	12 (12)	49	5-35 (18)	Granitic	Windswept
ABAM/PAMY	3580-3960 (3770)	Southeast	6-39 (23)	All	20-21 (20)	20-21 (20)	40-51 (46)	1-10 (6)	Variable	Limited data
ABAM/RHAL	3830-5500	North to East	8-68	All	22-30 (25)	18-25 (22)	23-42 (33)	1-8 (4)	Glacial till	Limited data
POTR/CARU	3790-6180 (5070)	All	3-48 (28)	Variable	44-46 (45)	33-46 (40)	26-29 (27)	1	Glacial outwash	Limited data
POTR/SYAL	3790-5240 (4750)	All	3-48 (31)	Variable	26	22	16	1	Basaltic till	Only one soil plot
LALY-OKAN	6470-6900 (6730)	Northerly	23-43 (26)	Mid to upper	No data	No data	No data	No data	No data	Limited data

because LALY is normally found extending to elevations above that reached by any other tree species on the Forest including PIAL.

As presented in this guide; pit depth is (1) the depth to bedrock, (2) the depth at which no further change is expected, or (3) the depth at which digging is so difficult that going deeper is not worthwhile. Rooting depth is the depth of the soil profile that contains 90% of the roots.

KEYS TO PLANT ASSOCIATIONS

Before using the keys, the field form in Appendix I should be filled out completely and cover estimates made. The sites should be as uniform as possible and representative of the area under examination. Don't include data from atypical microsites.

REMEMBER THE KEY IS NOT THE CLASSIFICATION!! Not all sites will key out to a type. Read the type descriptions and select the one that best fits. Some sites may not fit the classification at all because of data limitations, and because complex biological systems are not easily reduced to a few simple classes.

The steps below should always be followed for any of the keys in this document. (Modified from Hemstrom and others, 1982.)

1. Select a vegetatively uniform area for the sample. Plot size for vegetation data should be either 375 square meters or a 1/10 acre in size. (The radius of a 375 square meter plot is approximately 11 meters or 36 feet; a 1/10 acre plot has a radius of approximately 11.3 meters or 37 feet.)

2. Identify and list tree, shrub, and herb species and estimate the cover of each. Cover is estimated to the nearest percent up to 10 percent and to the nearest 5 percent thereafter.

3. Work through the key step by step and don't skip couplets. The key is a tool to help identify most sites but type descriptions should be reviewed to verify identifications. On severely disturbed sites check less disturbed areas nearby; then interpet using slopes, aspects, elevations, and soils.

It is important to follow the steps carefully since incorrect identification can lead to improper management interpretations.

Inasmuch as the associations are abstractions based upon individual plots grouped together based upon similarity; few stands will precisely fit descriptions of average stands in the association writeups.

KEY TO CLIMAX SERIES

Before using the key the steps outlined above should be completed.

1a. POTR the major tree species; conifers absent or if present less than 10 per acre. .... POTR SERIES KEY P.18.

1b. Not as above, or if POTR present conifers sufficiently represented to indicate eventual conifer dominance........ 2.

- 2a. ABLA2, PIEN, ABAM, TSME, PIAL or LALY separately or in combination with 10 or more trees to the acre........ 3.
- 3a. ABAM and/or TSME cover 5% or more. Cascade mountains only........ ABAM SERIES KEY P.17.
- 3b. ABAM or TSME absent or cover less than 5%........ 4.
  - 4a. PIAL and/or LALY cover 5% or more. Stands usually do not have a closed canopy. Often near upper tree line........ 5.
    - 5a. LALY cover 5% or more; aspects generally northerly and often above 7,000 feet elevation........ LALY ASSOCIATION P.73.
    - 5b. LALY absent or cover less than 5%. Sites are on windswept slopes with south to west aspects. PIAL is normally the major tree; but other conifers may be present, especially on the lee side of PIAL tree clumps. (If PHEM is present go to couplet 4b.). .... PIAL/CARU ASSOCIATION P.71.
  - 4b. Not as above, ABLA2 and/or PIEN with 10 or more trees to the acre........ ABLA2 SERIES KEY P.16.

2b. Not as above........ 6.

- 6a. PSME, LAOC, or PIPO separately or in combination sufficiently abundant to have 10 or more trees per acre........ PSME SERIES KEY P.16.

6b. Not as above .... 7.

7a. PICO is only tree present or if others are present they are confined to special microsites or are too few to meet criteria above .... PICO KEY P.18.

7b. If not as above; return to the beginning and reduce cover and number of trees requirement by one-half and try key again. The PICO key is longer and more complex than the others, so it should be used only when the others clearly cannot be used.

KEY TO PLANT ASSOCIATIONS IN THE PSME SERIES

Before using the key the steps on page 15 should be completed.

1a. PHMA present, or location is on eastern margin of the Okanogan National Forest and HODI cover more than 5% .... PSME/PHMA ASSOCIATION P.43.

1b. Not as above .... 2.

2a. VACA present .... PSME/VACCI ASSOCIATION P.33.

2b. VACA absent .... 3.

3a. ARUV cover 5% or more .... 4.

4a. PUTR present with ARUV .... PSME/ARUV-PUTR ASSOCIATION P.24.

4b. Not as above .... 5.

5a. Surface rock 10% or more, LIBOL absent; <u>Vacciniums</u> if present have 10% or less cover. .... PSME/ARUV ASSOCIATION P.27.

5b. Surface rock less than 10%; LIBOL often present one or more <u>Vaccinium</u> species present. .... PSME/VACCI ASSOCIATION P.33.

3b. ARUV absent or cover less than 5% .... 6.

6a. PAMY cover 5 % or more; individual shrubs usually well over 12 inches tall. Twisp or Methow River drainages only .... PSME/PAMY ASSOCIATION P.41.

6b. Not as above .... 7.

7a. SYAL OR SYOR cover 5% or more .... 8.

8a. SYOR present, and/or slopes greater than 30% .... PSME/SYOR ASSOCIATION P.38.

8b. Slopes less than 30% and SYOR absent .... PSME/SYAL ASSOCIATION P.36.

7b. SYAL OR SYOR absent or cover less than 5% .... 9.

9a. PIPO and/or PSME the only trees present. ARCO absent and AGIN more abundant than CARU .... PIPO-PSME/AGIN ASSOCIATION P.21.

9b. Not as above; CARU usually abundant and ARCO present .... 10.

10a. <u>Vaccinium</u> species with 5% or more cover .... PSME/VACCI ASSOCIATION P.33.

10b. <u>Vaccinium</u> species absent or with less than 5% cover. .... PSME/CARU ASSOCIATION P.30.

KEY TO PLANT ASSOCIATIONS IN THE ABLA2 SERIES

Before using the key the steps on page 15 should be completed.

1a. RHAL cover 5% or more; usually with several other shrubs such as LEGL, VASC, and PAMY. Mainly on steep northerly slopes above 4,500 feet elevation........................ ABLA2/RHAL ASSOCIATION P.64.

1b. RHAL absent or cover less than 5%.. 2.

2a. LEGL present and PHEM absent or with less than 5%.. 3.

3a. LEGL cover 5 % or more, sites are moist to wet often along a stream.
.... ABLA2/RHAL ASSOCIATION P.64.

3b. LEGL cover less than 5 % or sites are clearly not as above, VASC cover generally 25% or more... ABLA2/VASC ASSOCIATION P.61.

2b. LEGL absent or if occasionally present then PHEM with over 5% cover.......................... 4.

4a. VACA present and sites under 6,000 ft. elevation.............. ABLA2/VACCI ASSOCIATION P.46.

4b. VACA absent... 5.

5a. Equisetum species cover 5% or more soils are wet and boggy, streams or surface water usually evident.. PIEN/EQUIS ASSOCIATION P.67.

5b. Not as above.. 6.

6a. PAMY cover 5 % or more; individual shrubs well over 12 inches tall. Twisp or Methow River drainages only...............................ABLA2/PAMY ASSOCIATION P.52.

6b. Not as above.. 7.

7a. Vaccinium species absent; CARU cover 10% or more slopes southerly and over 30%; soils derived from sandstones or altered sandstones.
.... ABLA2/CARU ASSOCIATION P.58.

7b. Not as above.. 8.

8a. LIBOL absent. Most stands over 5,000 feet elevation; VASC cover usually 5% or more, or PHEM present... 9.

9a. PHEM present, stands open and trees appear stunted; lichens often dominate the sparse herbaceous plant layer.
.... ABLA2/PHEM ASSOCIATION P.69.

9b. Not as above. (Trees may be small but form closed stands)..... 10.

10a. CARU cover 5% or more; VASC and/or VAMY cover 5% or more.
.... ABLA2/VASC/CARU ASSOCIATION P.55.

10b. CARU absent or cover less than 5%; VASC cover 5% or more. (Most stands are dominated by PICO and over 5,000 feet elevation.)...................... ABLA2/VASC ASSOCIATION P.61.

8b. LIBOL present, or stands not as above. Some sites have few living plants evident... 11.

11a. ARUV usually present with 5% cover or more. One or more of the following Vacciniums present: VACA, VAMY, VAME, often with VASC. (If only VASC is present see couplet 9 or 10b.) Slopes usually 20% or less.......................... ABLA2/VACCI ASSOCIATION P.46.

11b. ARUV absent or cover less than 5%; LIBOL, Vaccinium species and slopes variable. PIEN often dominates stands.
.... ABLA2/LIBOL ASSOCIATION P.49.

KEY TO PLANT ASSOCIATIONS IN THE ABAM SERIES

ABAM is found only near the Cascade crest on the Okanogan National Forest and sampling was restricted to just that area east of the crest. ABAM is widespread on lands administered by the Wenatchee National

Forest and ABAM associations will be described in later work in greater detail. The Okanogan National Forest administers land west of the Cascade crest with considerable amounts of ABAM but the lands are within scenic and recreation areas and are not being managed for timber so no sampling was done.

Before using the key the steps on page 15 should be completed.

1a. RHAL present; cover 5% or more.. ABAM/RHAL ASSOCIATION P.75.

1b. Not as above.. ABAM/PAMY ASSOCIATION P.75.

KEY TO PLANT ASSOCIATIONS IN THE POTR SERIES

POTR is found in scattered locations throughout the Okanogan National Forest. Sampling of these stands was limited and only two plant associations are described. Many stands of POTR are seral to conifers; but some sites support POTR stands that appear stable or even climax.

Before using the key the steps on page 15 should be completed.

1a. SYAL cover 20% or more... POTR/SYAL ASSOCIATION P.75.

1b. SYAL absent or cover less than 20%... POTR/CARU ASSOCIATION P.75.

KEY TO ASSOCIATIONS WHEN PICO IS THE ONLY TREE PRESENT

This key applies to just those associations that can be dominated by PICO. It should be used only when the other keys will not work because: (1) PICO is the only tree present or (2) other conifers are confined to special microsites or have too few individuals to use the other keys. PICO grows on a wide variety sites but does not compete well in closed stands so it is often gradually replaced by more com petitive species. On some severe sites plant succession proceeds so slowly that PICO dominates for long periods of time and is maintained by periodic disturbances.

Before using the key the steps on page 15 should be completed.

1a. RHAL cover 5% or more; often with several other shrubs such as LEGL, VASC and PAMY. Most often on steep northerly slopes above 4,500 feet elevation........................ ABLA2/RHAL ASSOCIATION P.64.

1b. RHAL absent, or cover less than 5%.. 2.

2a. LEGL present.. 3.

3a. LEGL cover 5% or more, sites are moist to wet often along a stream. .... ABLA2/RHAL ASSOCIATION P.64.

3b. LEGL cover less than 5% or sites are clearly not as above; VASC cover 25% or more; grasses and sedges combined have less than 25% cover (unless area has been seeded). .... ABLA2/VASC ASSOCIATION P.61.

2b. LEGL absent.. 4.

4a. CARU absent or with cover less than 10%... 5.

5a. VASC cover 5% or commonly much more; often to the near exclusion of other species; PHEM absent or cover less than 5%; elevations usually above 5,500 feet; lower elevation sites are in frost pocket situations...................... ABLA2/VASC ASSOCIATION P.61.

5b. VASC absent or sites clearly not as above.. 6.

6a. PHEM cover 5% or more; elevations above 6,500 feet... ABLA2/PHEM ASSOCIATION P.69.

6b. PHEM absent or cover less than 5% elevations under 6,500 feet.................. 7.

7a. LIBOL absent; Vaccinium species absent or cover less than 5%. Surface rock often greater than 10%.. 8.

8a. ARUV cover 5% or more........................ PSME/ARUV ASSOCIATION P.27.

8b. ARUV absent or cover less than 5%........... PSME/CARU ASSOCIATION P.30.

7b. LIBOL usually present; Vaccinium species present. Surface rock never greater than 10%... 9.

9a. VACA present (check the descriptions of the PSME/VACCI and ABLA2/VACCI associations carefully to make final decision. The following couplet is of use in some instances)... 10.

10a. Elevations 5,000 feet or less, CHUMO and COCA usually absent. .... PSME/VACCI ASSOCIATION P.33.

10b. Elevations variable, CHUMO and/or COCA generally present. .... ABLA2/VACCI ASSOCIATION P.46.

9b. VACA absent.. 11.

11a. ARUV cover 5% or more; see note on couplet 9a above............ 10.

11b. ARUV absent or cover less than 5%.............................. 12.

12a. PAMY cover 15% or more; individual shrubs well over 12 inches tall. Twisp or Methow River drainages only. .... ABLA2/PAMY ASSOCIATION P.52.

12b. Not as above.................... ABLA2/LIBOL ASSOCIATION P.49.

4b. CARU present and with cover of 10% or more.. 13.

13a. PAMY with 15% or more cover; individual shrubs well over 12 inches tall. Twisp or Methow River drainages only.. ABLA2/PAMY ASSOCIATION P.52.

13b. Not as above.. 14.

14a. VACA and LIBOL absent; other Vaccinium species absent or cover 5% or less.......... 15.

15a. Soils derived from sandstone or altered sandstones; usually on Winthrop Ranger District.. ABLA2/CARU ASSOCIATION P.58.

15b. Not as above.. PSME/CARU ASSOCIATION P.30.

14b. Not as above.. 16.

16a. VACA present. Return to couplet 9a above................................. 9a.

16b. VACA absent.. 17.

17a. Surface rock greater than 10%; and ARUV cover 5% or more. .... PSME/ARUV ASSOCIATION P.27.

17b. Not as above.. 18.

18a. Elevations over 4,800 feet; slopes 25% or more; LIBOL and/or ARUV absent or each with cover less than 5%; one or more Vaccinium species with with cover 5% or more...................... ABLA2/VASC/CARU ASSOCIATION P.55.

18b. Not as above.. 19.

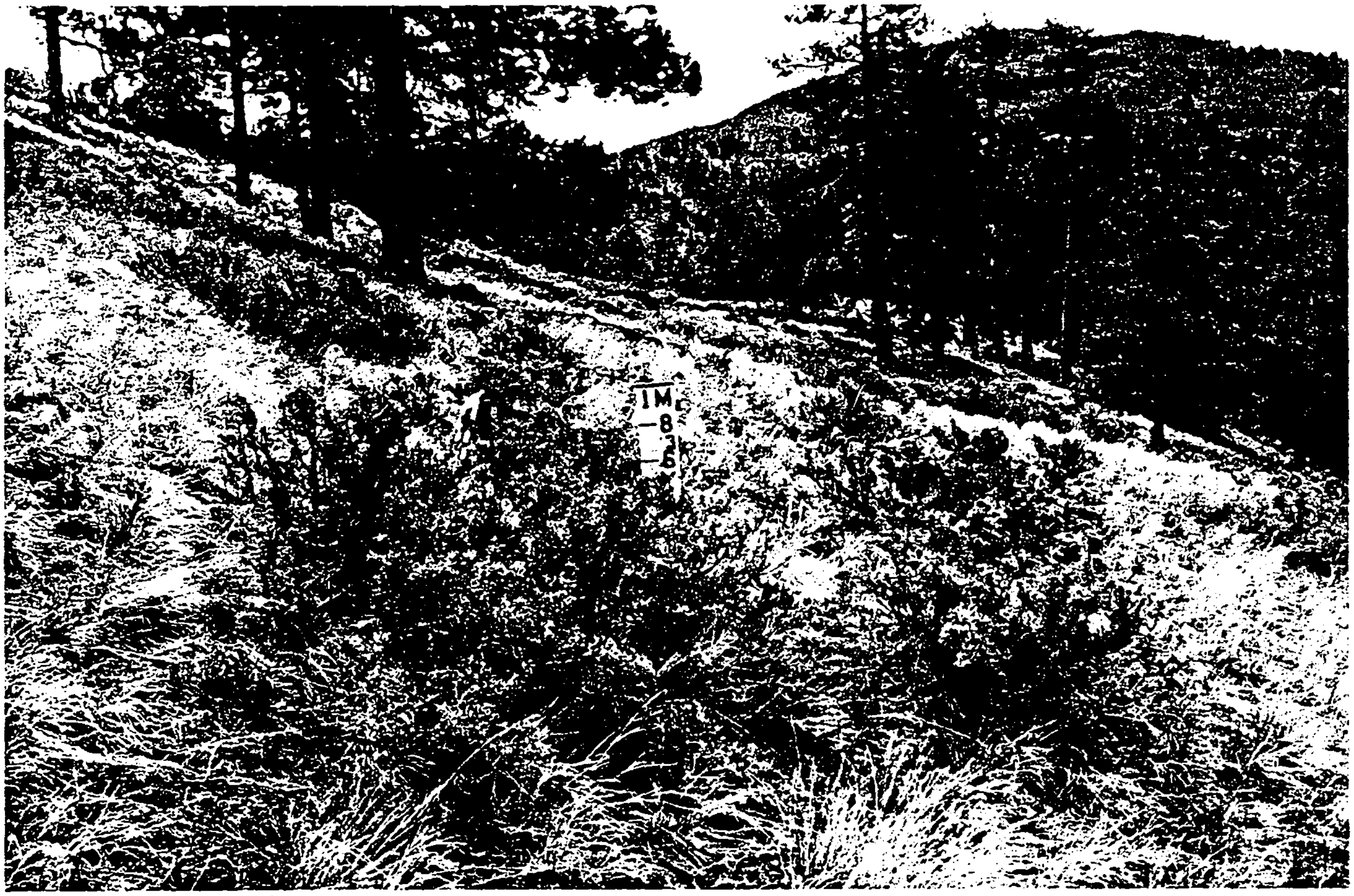
19a. ARUV absent or cover less than 5%; slopes variable, as is presence of Vaccinium species................. ABLA2/LIBOL ASSOCIATION P.49.

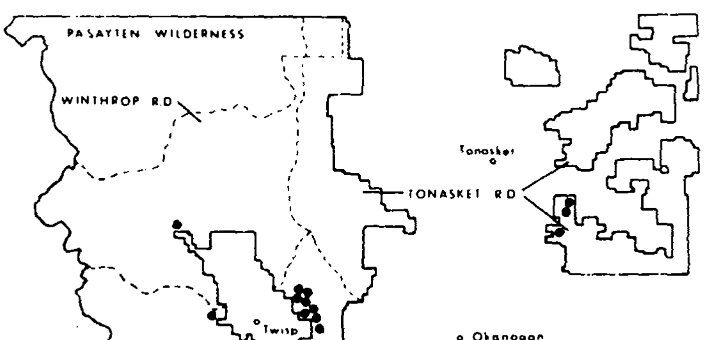
19b. Return to couplet 9a for comments, and to couplet 10 for associations. Not all sites will work through the key; so type descriptions must be carefully reviewed to confirm identifications.

PIPO-PSME/AGIN ASSOCIATION CD-G3-11

Pinus ponderosa - Pseudotsuga menziesii/Agropyron spicatum var. inerme

Ponderosa pine - Douglas-fir/beardless bluebunch wheatgrass





INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all districts of the forest. With a mean elevation of 3,433 feet and range of 2,400-4,700 feet. Aspects range from southeast to west and slopes range from 12% to 68% (average 44%). Slope positions range from upper to lower 1/3 and microrelief is usually flat or concave. Soils are normally derived from granitic till or outwash, usually with sandy loam to sand textures. Coarse fragments range from 19% to 52% (average 40%). Surface rock ranges from 1%-50% (average 9%). Pit depths range from 16-53 inches (average 34) and rooting depths from 12-35 inches (average 23). Soil temperatures indicate very warm site conditions; this data with vegetation and physical characteristics suggest this is the driest and warmest forested association on the Okanogan National Forest.

VEGETATIVE COMPOSITION:

PIPO is always present and dominates most stands with an average cover of 28%. Large, old PIPO normally characterize the overstory. PSME is present in 80% of the sample stands, but cover averages only 12%. A few stands are nearly pure PSME with little PIPO. No other tree species are found in the type. At elevations below the National Forest lands, a similar association has been observed where PSME is absent. Overstory tree cover averages about 39%.

On the Tonasket District PUTR is absent, but on the rest of the Forest PUTR is often the most conspicuous shrub present. It averages 11% cover. No other shrubs exceed 50% constancy, but AMAL and RICE are often present.

AGIN is 100% constant and cover averages 30%. BASA and FEID have constancies greater than 70%, with average cover of 10% and 16%, respectively. ACMI, ANTEN, BRTE, COPA, CRAT, KOCR and LUSE are occasionally abundant and have greater than 50% constancy.

It is possible to subdivide this broadly defined association by separating stands with PUTR and then those where FEID is the dominant grass. This was first done, but later it was decided to lump the groups because of limited acreages involved and similar management implications and productivity levels.

INDICATORS:

The lack of any trees except PIPO or PSME distinguishes this type from others on the Forest. Dominance of AGIN with or without CARU is characteristic. ARCO and CACO with CARU indicates a transition to the PSME/CARU type. This association does not contain ARUV, separating it from the PSME/ARUV type. CARU indicates a somewhat cooler and more moist environment. Figure 7 portrays the relationship of this type to others on the Forest.

Productivity:

The low basal areas and site indexes for this type result in low cubic foot volume. Lack of moisture appears to be the main factor limiting tree growth.

Essentially, this association is a natural grassland with a scattering of trees in favorable microsites. The microsite variation results in a "patchy" stand structure and accounts for some of the variation in tree volume productivity estimates. Using SDI to adjust for stand density, mean timber production is less than 20 cubic feet per acre per year. Volume estimates using SI-GBA are much higher due in part to the patchy nature of the stands. GBA is a tree-centered sampling procedure, so samples tend to be in the densest portions of the stands and are not representative of general conditions.

Herbage production potential is good. This association, and those with CARU as part of their name, produce over 200 lbs/acre mean herbage; over twice that of any other type and nearly twice the 104 lb/acre average of the PSME series.

Successional Relationships:

These sites are too harsh to form closed stands, so it appears that PIPO will never be competitively eliminated by the more shade tolerant PSME.

The droughty nature of the stands and the frequent ground fires create conditions favorable to the continued dominance of PIPO. Firescars indicate a historical fire periodicity of 5 to 30 years. PUTR is sensitive to fire, especially to hot fires in summer or fall. However, all sampled PUTR stands were burned in the past. the long-term health of PUTR may be dependent on periodic rejuvenation by fire. Unlike PUTR, most other species resprout readily after fire.

Silviculture:

Nearly all stands examined are low in productivity; most are below 20 cubic feet per acre per year. There is little potential of increasing production with intensive management practices. Heavy past logging is evidenced by numerous stumps, yet regeneration is usually sparse due to severe site conditions. Heavy grazing may improve tree establishment by reducing grass competition. Regeneration is difficult to assure after logging under normal weather conditions.

Range Management:

This association is valuable for livestock forage. Areas with PUTR are especially valuable for deer winter range. High cover of BRTE and other annuals, with reduction in native bunchgrass cover, indicates past overgrazing. LUSE and BASA may increase under grazing pressure. Management of livestock should be keyed mainly to the sensitivity of AGIN. This is true even with significant amounts of FEID because: (1) FEID is not as sensitive to abusive grazing as AGIN, and (2) FEID is often grazed by cattle before they start on AGIN. The high quality of FEID as forage should be considered in management. Both AGIN and FEID are most sensitive to heavy defoliation at approximately the same growth stage; that is, from flowering to seed ripening (Mueggler, 1980). The calendar dates of the sensitive growth stages of these two important forage grasses coincide reasonably well, which simplifies management (Mueggler, 1980). Use drought tolerant grasses in reseeding. Noxious weeds such as CEDI pose a serious threat, especially in disturbed areas.

Comparisons:

McLean (1970) describes a PSME/FEID association just north of our area with a tree stratum identical to our PIPO-PSME/AGIN association. His understory composition differs from ours and PUTR is absent from his area. He also has a PSME/AGSP association, but PIPO is much less common and the shrub and herb layers are also much different.

Brayshaw (1965), in southern British Columbia, has a PSME/AGSP association that lacks PIPO. He also describes a PIPO/AGIN association with no PSME. His associations contain species not common to our type. Steele and others (1981), in Idaho, have a PSME/AGSP association that resembles some of our stands. Daubenmire and Daubenmire (1968) in eastern Washington and northern Idaho; Pfister and others (1977) in Montana; Hall (1973), Volland (1976), and Hopkins (1979A and 1979B) in Oregon; Hoffman and Alexander (1976 in Wyoming; each describe one or more associations where PIPO is climax and PSME absent or uncommon. These stands resemble many of ours in appearance, but differ greatly in composition.

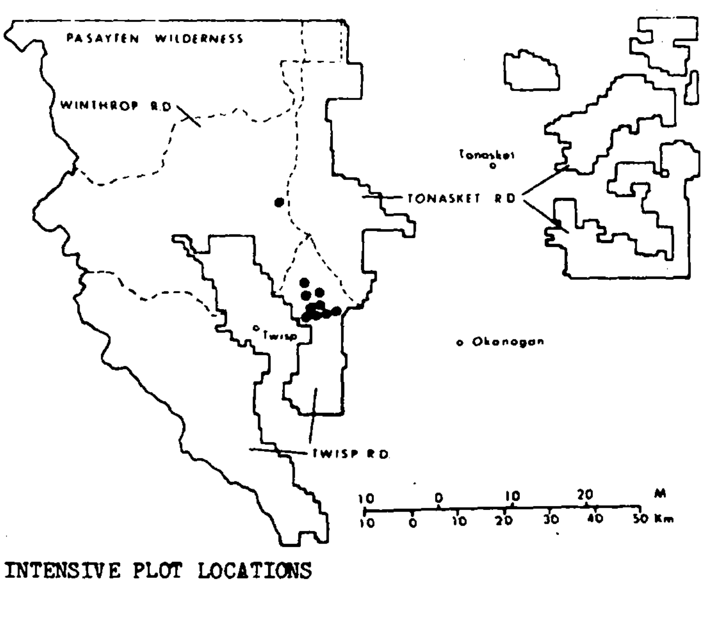
PRODUCTIVITY ESTIMATES

Plots = 15	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	250	95-378	55	25.8
TBA (sq. ft/acre)	56	24- 84	10	4.9
STAND DENSITY INDEX (SDI)	93	43-143	19	9.1
SDI GROWTH EST (cu. ft/ac/yr)	12	5- 20	3	1.4

SPECIES (# plots)	SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
	Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PIPO (15)	68	5	2.3	71	12	5.5	25	5	2.6
PSME (3)	65	**	**	97	**	**	32	**	**

** Indicates insufficient data for statistical calculations.

PSME/ARUV-PUTR ASSOCIATION CD-S6-31
Pseudotsuga menziesii/Arctostaphylos uva-ursi - Purshia tridentata
Douglas-fir/bearberry - bitterbrush



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all three Districts, but only west of the Okanogan River. Elevations range from 2,680 to 4,800 feet (average 4,156) and aspects range from east to west, but are generally southerly. Most slopes are steep, ranging from 19% to 63% (average 43%). Slope position is usually middle 1/3, but ranges from ridgetop to occasionally lower 1/3 with generally flat to convex microrelief. Some sites are in valley bottoms on flat ground with compacted glacial tills. Soils are normally derived from granitic till or outwash, usually with sandy loam to sand textures. Coarse fragments range from 23%-45% (average 35%) and surface rock ranges from 0%-35% (average 15%). Pit depths are from 16-40 inches (average 28) and rooting depths range from 10-28 inches (average 19) with compacted till limiting root penetration on most sites. This association indicates warm and dry growing conditions, but stands at upper elevations may experience frost during the growing season. This type is not as hot and dry as

PIPO-PSME/AGIN, but is warmer and drier than PSME/CARU. Trees are not noticeably restricted to more favorable microsites as in the PIPO-PSME/AGIN association.

VEGETATION COMPOSITION:

PSME and PIPO are present in most stands with one or the other usually dominating. PICO is present in 25 percent of the samples. PSME normally dominates the regeneration, but PIPO is often present in the reproductive layer. Overstory tree cover averages about 44%.

ARUV and PUTR are the only shrubs with 100% constancy and averaged 13% and 6% cover, respectively. CEVE, PAMY and SPBEL are the only other shrubs that have 50% or more constancy and they are low in cover.

CARU and CACO are the most common herbaceous species with mean coverages of 15% and 2%, respectively. CARU has reduced cover or is absent on very sandy soils. Other herbs frequently present, but not usually abundant, are ACMI, ANUM, ARCO, CARO, COPA, HIAL and PEPR2. AGIN was not as common as these species, but averaged 11% cover where found.

INDICATORS:

PUTR and ARUV together distinguish this association from all others in the area. Decreasing ARUV, SPBEL, and ARCO with increasing LUSE, BASA and FEID suggest a transition toward the more xeric PIPO-PSME/AGIN association. Lack of PIPO regeneration and increasing ARCO and CARU indicate a transition toward the PSME/CARU type. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

SDI estimate of timber productivity at 22 cu. ft/ac/yr is well below the 36 cu. ft/ac/yr average of the PSME series. Absolute productivity may exceed 20 cu. ft/ac/yr. This site is more productive than the PIPO-PSME/AGIN association as indicated by higher SDI, productivity estimates and basal areas. Herbaceous production is fair, averaging 74 lbs/ac, well below the 104 lbs/ac average of the PSME series. High coarse fragments and shallow rooting depths may account for much of the reduced herbage production when compared to the PIPO-PSME/AGIN association, though both have similar overstory canopies. Overstory removal will probably not improve herbage production a great deal.

SUCCESSIONAL RELATIONSHIPS:

PIPO dominates the overstory in most stands and replacement by PSME is suggested by its more prevalent regeneration, but is slow. Logging generally retards succession by opening up the stand and thereby favoring PIPO regeneration. Fire, a common past occurrence on these sites as indicated by fire scars, has played a major role in the dynamics of the sere. Recently burned stands often have high cover of CEVE and little or no PUTR. Some sites are relatively barren with PICO as the major tree and SHCA as the most conspicuous shrub. These appear to be areas that have repeatedly burned in the past. PUTR shows a greater response of CEVE to burning than any others.

SILVICULTURE:

Hot and dry southerly aspects can create severe moisture and temperature stress, especially on young trees. PIPO is recommended for planting, especially on the more sandy soils. Shading to protect seedlings from direct insolation may be necessary. Herbaceous and shrub competition should not be a problem. Although CARU is often present, it does not exhibit the ability to form a strong sod detrimental to planted trees.

RANGE MANAGEMENT:

Herbaceous production is moderate with sites transitional to the PIPO-PSME/AGIN association often more productive. Many areas representative of the association are rocky and revegetation potential is limited. Sandy sites do not normally have much herbaceous vegetation. Overgrazing seems to reduce the amount of forage produced by elimination of the plants, but invasion by weedy species is limited. BRTE, for example, does not appear in any of the sample plots.

Sites are valuable for deer winter range because of palatable shrubs and they remain snow-free longer and green-up earlier in the spring than other associations.

COMPARISONS:

This type has not been described from other areas. Some of the plots that Steele and others (1981) include in their AGSP phase of the PIPO/PUTR association may be similar.

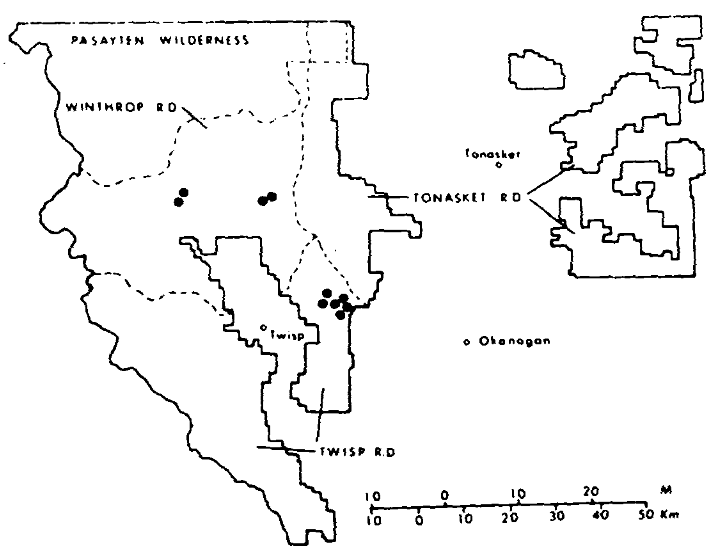
PRODUCTIVITY ESTIMATES

Plots = 10	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	74	8-215	51	22.5
TBA (sq. ft/acre)	99	55-128	29	12.7
STAND DENSITY INDEX (SDI)	176	113-329	50	22.3
SDI GROWTH EST (cu. ft/ac/yr)	22	9- 48	9	3.9

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PIPO (10)		70	4	1.6	98	26	11.5	35	9	4.2
PSME (7)		66	3	1.4	84	24	9.8	28	7	3.1
PICO (1)	70*	38	**	**	118	**	**	41	**	**

* Site index adjusted to a base 100 scale.
** Indicates insufficient data for statistical calculations.

PSME/ARUV (OKAN) ASSOCIATION CD-G1-23
Pseudotsuga menziesii/Arctostaphylos uva-ursi
Douglas-fir/bearberry



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association was sampled on the Twisp and Winthrop Districts only, but stands were observed on the Tonasket District. Elevations range from 3,960 to 5,380 feet (average 4,712 feet). Aspects range from east to west, but are usually southerly. Slopes are often steep, ranging from 3% to 70% (average 34%). Slope position is usually ridgetops to upper 1/3 slopes, with convex microrelief. Most soils are derived from granitic glacial outwash with sandy loam to sand textures. Ash is mixed in the upper portion of some profiles. Coarse fragments range from 29%-39% (average 35%) and surface rock ranges from 5%-25% (average 13%). Pit depths range from 18-35 inches (average 26) and rooting depth from 10-26 inches (average 19).

Soils have high coarse fragment percentages, surface rock is also high. Large boulders and rock outcrops are often conspicuous. No soil pit exceeded 35 inches depth because of the difficulty of digging, but bedrock was not reached in any pits. These conditions render the soil effectively shallow. Because of the elevations, frost heaving is a potential hazard. Suggesting a cool-dry environment for plant growth.

VEGETATION COMPOSITION:

These stands often occur as rocky islands within the PSME/CARU type. PSME is the dominant tree species in most stands and occurs in all sample plots with mean overstory cover of 28%. Overstory constancy of PICO, PIPO and LAOC is 67%, 60% and 37%, respectively. Often PIPO and PICO have overstory coverages exceeding 10%, while LAOC only twice exceeds this amount. When compared with the PSME/CARU association, PICO and PIPO occur more frequently, but LAOC is less common. Total average tree cover is 49%.

ARUV is the most prevalent shrub with 100% constancy and 15% average cover. PAMY has 67% constancy and 2% average cover. SPBEL is present in over half the samples and averages 4% cover. Other shrubs, including SHCA, VAMY and ROSA, are variable in cover and constancy.

CARU is present in 26 of the 30 samples, with an average cover of 17%. ANRA, CACO and ARCO are near 50% constancy, but rarely exceed 5% cover.

INDICATORS:

The presence of ARUV, normally without Vacciniums, and the high surface rock separates this type from others on the Forest. Increasing CARU with decreasing ARUV and surface rock without a corresponding increase in Vacciniums and LIBOL indicate transition to the PSME/CARU type. Decreasing rock with increases in CARU, LIBOL and Vacciniums indicate a transition to the PSME/VACCI association. Lack of PUTR separates this type from the PSME/ARUV-PUTR type. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

The timber productivity estimates suggest that cubic foot volume is low to moderate. Site indexes are low for all species, but basal areas are high enough for most sites to be moderately productive.

Herbaceous production is fair, averaging 65 lb/acre; well below the 104 lb/acre average for the PSME series. This estimate may be low because one plot is in an old stock driveway where little herbaceous vegetation exists.

SUCCESSIONAL RELATIONSHIPS:

Under most conditions the successional trend toward a PSME climax is clear. Normally PSME dominates the overstory and regeneration and no other species exhibits the ability to replace it. High cover of CEVE often results from recent fire. Large amounts of annual species indicate past disturbances such as heavy grazing. One overgrazed stock driveway has little herbaceous vegetation, though it has been years since the driveway was used.

SILVICULTURE:

Effectively shallow soils and potential frost conditions are major management concerns. Several tree species can be grown, but successful regeneration may be difficult. Some shelter from excessive insolation and frost is suggested. Because of temperature limitations, PIPO is not recommended for sites over 4,800 feet elevation. Careful attention should be paid to slope position and cool air drainage patterns.

RANGE MANAGEMENT:

As the amount of coarse fragments increase, forage production tends to go down. Standard pasture grasses are suitable for revegetation. Most seeded grasses are eventually replaced by CARU. CARU is well utilized by cattle, and not avoided to the extent it is in the Blue Mountains of Oregon. CARU often shows appreciable use even in areas with palatable seeded species.

COMPARISONS:

Pfister and others (1977) describe a PSME/ARUV association in Montana, but species composition and environmental conditions are much different. Their ARUV phase of the PSME/CARU is more similar to our type than their PSME/ARUV association. However, it contains more PIPO and ARUV and less SHCA and species not found in our area. Several studies in British Columbia have described associations where PSME, ARUV and CARU are important members of the stands. McLean (1970) discusses these various studies in detail. Brayshaw (1965) has a PSME-PIPO/ARUV association that appears comparable to ours. Most Canadian works defined their associations more broadly than we did ours, so their types are not directly comparable. McLean treated it as an ARUV phase of a PSME/CARU association. Daubenmire and Daubenmire (1968) mention an ARUV phase with their PSME/CARU association, but their plots appear to fit better in our PSME/VACCI association because their data includes Vaccinium species.

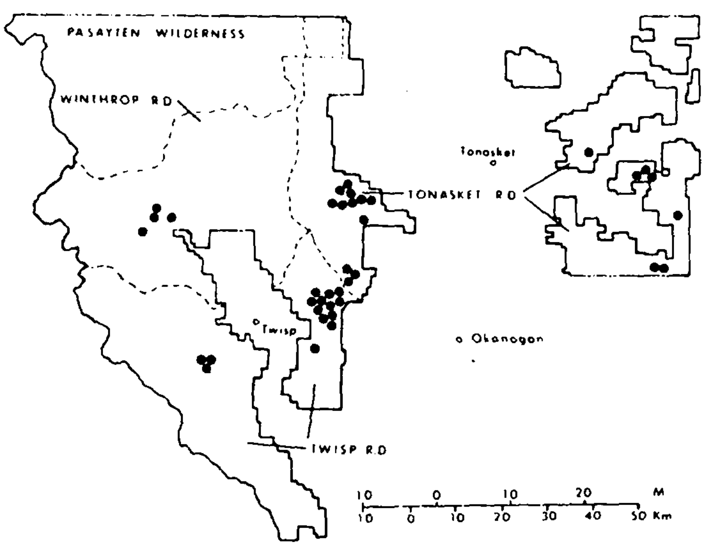
PRODUCTIVITY ESTIMATES

Plots = 8	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	64	5-160	50	20.3
TBA (sq. ft/acre)	153	114-192	25	10.4
STAND DENSITY INDEX (SDI)	290	214-499	79	33.6
SDI GROWTH EST (cu. ft/ac/yr)	20	10- 41	8	3.4

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (8)		57	5	2.1	102	18	7.6	35	7	2.9
PIPO (4)		59	2	0.8	147	62	19.5	43	17	5.3
PICO (4)	47*	27	11	3.3	140	67	21.1	33	29	9.2
LAOC (2)	70*	43	**	**	118	*8	**	41	**	**

* Site index adjusted to a base 100 scale.
** Indicates insufficient data for statistical calculations.

PSME/CARU (OKAN) ASSOCIATION CD-G1-31
Pseudotsuga menziesii/Calamagrostis rubescens
Douglas-fir/pinegrass



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is the most common and widespread one on the Forest. Elevations range from 2,660 to 5,290 feet (average 4,521). Aspects are variable, but often are southerly at higher elevations. Slopes are usually steep, ranging from 1% to 74% (average 35%). Slope position is most often middle 1/3 to ridgetop, but the association may occur in all positions, generally with convex to flat microrelief. Soils are derived from various parent materials, but usually have sandy loam to sand textures and range from 19% to 56% (average 35%) in coarse fragments. Surface rock ranges from 1%-20% (average 4%). Pit depths range from 10 to 62 inches (average 32) and rooting depths range from 10 to 28 inches (average 19).

Daubenmire and Daubenmire (1968) state that this type is indicative of a relatively cool, dry environment. In our area, it appears to be between PSME/ARUV-PUTR on warmer and drier sites, and PSME/ARUV on cooler but drier conditions.

VEGETATIVE COMPOSITION:

PSME dominates most stands regardless of seral stage. PIPO, LAOC and PICO are often present and sometimes dominate with overstory constancies of 44%, 43% and 32%, respectively. PICO did not dominate any stands below 4,700 feet. ABLA2 and PIEN occur as accidentals if at all in this association. Mixed species stands are common, but it is not unusual for PSME to be the sole tree species in old growth stands. Any of the species listed above may be present in the regeneration layer, but PSME normally dominates. Overstory tree cover averages about 56% in the PSME/CARU association.

Shrubs are generally inconspicuous in this association. PAMY is the only shrub that exceeds 50% constancy, but it is dwarfed in growth form and inconspicuous with an average cover of 4%. Other shrubs that occur with some regularity but low cover include SPBEL, ARUV, BEAQ, SASC, SYOR and ROSA.

CARU is present in all stands with average cover of 45%. ARCO has 73% constancy and average cover of 6%. Later in the season, ARCO may be overlooked as it dries up. Other species that may be abundant are AGIN, ANRA, ASMI and LUSE. ACMI, CACO and FRAGA are often present, but not normally abundant.

INDICATORS:

CARU dominates the understory to the extent that other species are inconspicuous. Daubenmire and Daubenmire (1968) described the general appearance of the understory as: "A brilliant green sward, the uniformity of which is enhanced by the notable lack of inflorescences and the uniform spacing of grass tillers..."

Presence of AGIN and BASA with ARCO and CACO indicate sites approaching the PIPO-PSME/AGIN association, but still best fit the PSME/CARU association. Lack of ARCO and CACO, coupled with presence of AGIN and BASA, indicate the site best fits the PIPO-PSME/AGIN association. Increasing PUTR and ARUV indicates transition to the PSME/ARUV-PUTR association. Increasing surface stoniness and a corresponding increase in ARUV indicate a transition to the PSME/ARUV association. Increasing PICO and occasionally ABLA and PIEN indicate sites at the cooler extremes of the association. PIEN and ABLA occur most commonly on soils derived from sandstone or altered sandstone. Figure 7 portrays the relationship of this type to the others on the Forest.

PRODUCTIVITY:

Timber productivity for the type is moderate to good compared to other associations where PSME is the indicated climax species. PSME productivity is good at all elevations, but PIPO and LAOC productivity is better at elevations below 4,600 feet.

Herbage production is relatively high but tends to decrease as soil coarse fragments and tree overstory increases. Removal of tree cover will increase herbage production if the sites are not seriously disturbed.

SUCCESSIONAL RELATIONSHIPS:

On most sites, the trend toward a PSME climax is clear. Normally the tree overstory and reproduction are dominated by PSME. Intense fires favor PICO at higher elevations and PIPO and LAOC at mid to lower elevations, even though mature PSME are quite fire resistant.

Most forms of moderate disturbance (with the exception of grazing) stimulate growth of CARU. Dense tree cover, heavy grazing, severe fires or scarification decrease CARU cover. Areas at the drier extreme of the association resemble the PIPO-PSME/AGIN association in species composition and appearance following an intense wildfire. CARU is slower to re-assert its dominance on these sites.

SILVICULTURE:

Prompt regeneration following harvest is essential to reduce CARU competition. Planting is recommended and should immediately follow harvest. Delay in planting may create severe regeneration problems from herbaceous competition.

CARU can be killed by hot broadcast burns, but damage to the soils may result. One broadcast burned and planted site within the PSME/CARU association has adequate regeneration only in the unburned parts. Mechanically scarified areas on the same site have good survival of the planted trees and adequate stocking. Conversely, many other broadcast burned sites within the association usually have good planting success. These observations do not preclude the use of broadcast burning as a means of site preparation, but they do indicate that there are still many factors in apparently similar sites which are not fully understood. No single treatment is applicable to all conditions.

Sites near 5,000 feet or higher elevation may show slow growth for the first 20 to 30 years until reaching a stump diameter of 4 or 5 inches; then grow rapidly for 30 or 40 years to a diameter of 12 to 16 inches before the rate slows again. Apparently, on these sites trees regenerate and grow slowly until large enough to provide mutual shelter from frosts and cold temperatures and to overcome CARU competition. Then a period of rapid growth occurs until the trees are large enough to compete with each other and reduce growth rates. Other explanations can be offered, but the above appears to be the most likely on present information.

What appears to be laminated root rot centers (Phellinus weirii) are common in many stands.

On sites transitional to PIPO-PSME/AGIN and on lower elevation areas, PIPO is recommended. PSME or LAOC are suggested at elevations below 4,600 feet and PSME is recommended at higher elevations.

RANGE MANAGEMENT:

Standard pasture grasses are suitable for revegetation. Most seeded grasses are eventually replaced by CARU. CARU is grazed well by cattle, and not avoided in our stands to the extent it is in the Blue Mountains of Oregon. CARU often shows appreciable use even in areas with palatable seeded species.

COMPARISONS:

Daubenmire and Daubenmire (1968) in northern Idaho and eastern Washington, Pfister and others (1977) in Montana, and Steele and others (1981) in central Idaho all report similar PSME/CARU associations.

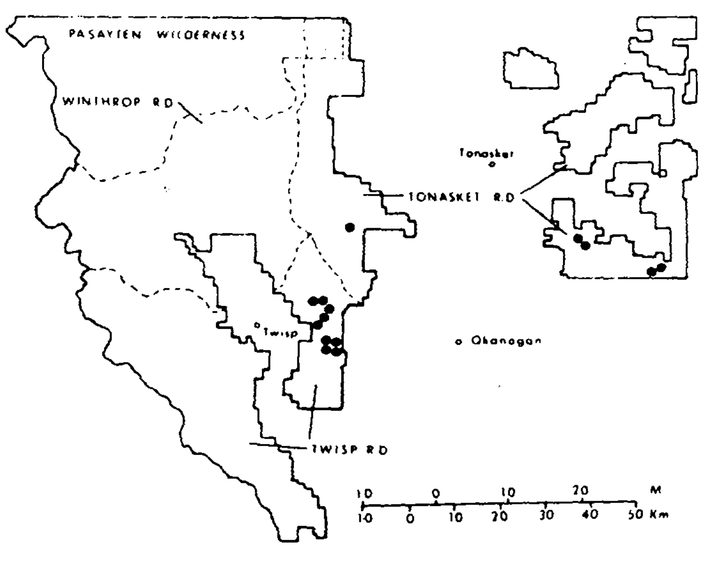
PRODUCTIVITY ESTIMATES

Plots = 39	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	199	60-600	49	24.3
TBA (sq. ft/acre)	179	91-296	19	9.4
STAND DENSITY INDEX (SDI)	276	92-540	36	17.8
SDI GROWTH EST (cu. ft/ac/yr)	35	12- 82	5	2.5

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (36)		77	3	1.5	178	18	8.8	68	7	3.6
PICO (4)	65*	39	5	1.5	150	124	39.1	49	43	13.5
PIPO (14)		78	6	2.7	140	27	12.6	51	10	4.8
LAOC (16)	87*	55	6	2.8	138	25	11.5	60	13	6.0

* Site index adjusted to a base 100 scale.

PSME/VACCI ASSOCIATION CD-S8-11
Pseudotsuga menziesii/Vaccinium
Douglas-fir/huckleberry



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts, but normally only east of the Methow River. Nearly all samples were taken on the Twisp and Tonasket Districts, with some on the extreme eastern part of the Winthrop District. Elevations range from 3,000 - 4,860 feet (average 4,240). Aspects are variable and slopes moderate, ranging from 20%-38% (average 28%). Slope position is usually middle 1/3, but ranges from ridgetop to lower 1/3, with flat to convex microrelief most common. The often mottled soils are normally formed in glacial till or outwash (often granitic) with a thin layer of volcanic ash on the surface. Because of the volcanic ash, the top few inches often have a silt loam texture with subsoil textures sandy loams to sands. Coarse fragments range from 11% to 41% (average 27%) and surface rock from 0% to 5% (average 3%). Pit depths were 20-38 inches (average 28) and rooting depth ranged from 14 to 35 inches (average 20) with compacted tills limiting root penetration on most sites. Some sites appear to have high water tables and pH appears lower (more acid) than in many other associations. These sites are generally moist and cool to cold, often being near streams and drainageways. This is the coldest and wettest association within the PSME series.

VEGETATIVE COMPOSITION:

PSME is found in all stands, although LAOC or PICO often dominate the overstory. LAOC is more frequent and abundant in this association than any other in the PSME series, but PIPO is less common and abundant than any other in the series with the exception of the PSME/PHMA association. Two or more tree species are the rule and no single species stands were encountered. Overstory tree cover averages 51%, but often is much higher. PSME dominates tree reproduction even though no climax stands have been observed.

The shrub layer is generally low in stature, but species rich. The most common and abundant species are ARUV, PAMY, SPBEL and one or more of the Vacciniums: VAMY, VACA and VAME. LIBOL is occasionally abundant, as is SHCA. No shrub is found in all plots.

CARU is constant with over 30% cover normal. The heavy CARU sward often conceals low shrubs. Herbs that may be abundant include ASMI, LULA, ARCO and LUSE.

INDICATORS:

Vaccinium species with ARUV and often with LIBOL helps distinguish this type. The presence of Vaccinium species and PICO in abundance and the relative absence of PIPO suggest cool and frosty growing conditions. Reduction in Vaccinium species and ARUV with increase in PIPO and CARU indicates a transition to the somewhat warmer and more xeric PSME/CARU association. Decrease in CARU, Vaccinium species and LIBOL with an increase in surface rock indicates transition to the PSME/ARUV type. PSME/VACCI can be distinguished from ABLA2/VACCI by the lack of ABLA2 or PIEN regeneration. Figure 7 portrays the relationship of this type to the others on the Forest.

PRODUCTIVITY:

SDI estimate of timber productivity in this association is near 37 cu. ft/ac/yr average for the PSME series and near that of the PSME/CARU association. The PSME/CARU association has higher basal area and higher site indexes for all species except PICO. Cool temperatures and shallow soils appear to limit tree growth in the PSME/VACCI association. Herbaceous production is fair at 77 lbs/acre, well below the 104 lbs/acre average for the PSME series. However, some plots were from areas that had been heavily grazed and the data may be deceptive. Potential for increase in herbage production with overstory removal is excellent.

SUCCESSIONAL RELATIONSHIPS:

Though LAOC and PICO dominate most stands, PSME dominates reproduction indicating a trend toward eventual PSME dominance. Overstory removal may advance succession by giving PSME early dominance of the overstory. All shrubs and most forbs resprout following all but the hottest fires. Vacciniums have brittle stems and are sensitive to damage by equipment or large animals. FRAGA increases with grazing and ARUV appears to increase, but may simply become more visible with reduction in CARU cover. Fire has been common in most stands with a 10-40 year interval between scars. SHCA is favored by fire.

SILVICULTURE:

Frost and cool growing conditions apparently are the main limitations to tree growth. Low shrub and herbaceous cover increase after logging so regeneration should promptly follow harvest. Two or more growing seasons delay may create severe herbaceous competition. Natural regeneration potential is good if frost pockets are avoided and CARU cover is less than 20%. High CARU cover may hinder regeneration. The gentle slopes and abundant CARU normally found here reduce the need of grass seeding for erosion control.

COMPARISONS:

The PSME/VACCI association is similar to the PSME/VACA association in Montana described by Pfister and others (1977). However, VACA is near its western range extension in our area. Their data shows more PIPO and less LAOC and we lack CAGE and XETE that they show in many stands. Steele and others (1981) report the same association from central Idaho, but gives no data. Daubenmire and Daubenmire's (1968) ARUV phase of the PSME/CARU association resembles our PSME/VACCI association.

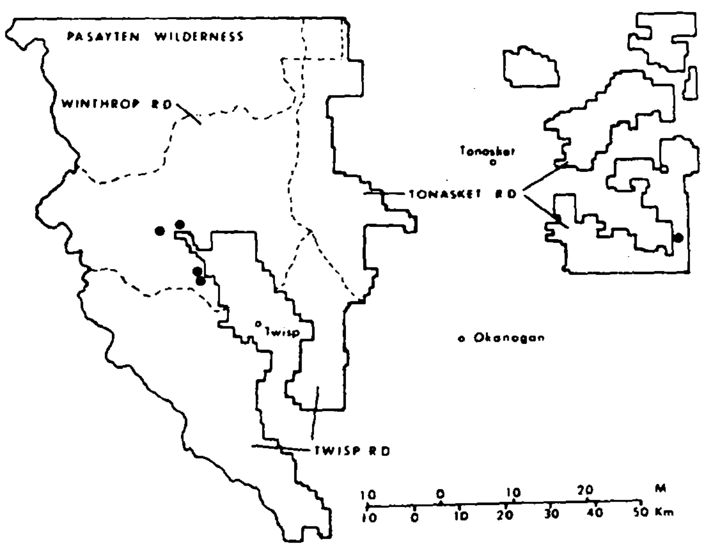
PRODUCTIVITY ESTIMATES

Plots = 14	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	77	13-177	37	17.2
TBA (sq. ft/acre)	152	98-198	16	7.4
STAND DENSITY INDEX (SDI)	278	166-430	42	19.3
SDI GROWTH EST (cu. ft/ac/yr)	37	15- 54	8	3.8

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (12)		73	5	2.4	144	23	10.4	56	11	5.1
LAOC (12)	82*	53	7	3.2	119	22	10.2	49	13	5.8
PICO (10)		45	7	2.9	145	22	9.8	52	9	3.9
PIPO (1)	72*	70	**	**	119	**	**	42	**	**

* Site index adjusted to a base 100 scale.
** Indicates insufficient data for statistical calculations.

PSME/SYAL (OKAN) ASSOCIATION CD-S6-33
Pseudotsuga menziesii/Symphoricarpos albus
Douglas-fir/snowberry



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts, but is most common on the Winthrop District. Elevations range from 2,640 to 4,200 feet (average 3,315) and the type occurs on all aspects. Slopes are gentle to moderate, never exceeding 30%. Slope position is usually mid to lower 1/3 slopes to benches with flat or concave microrelief. Most soils are derived from sedimentary till or outwash with sandy loam to sand textures. Coarse fragments range from 6% to 52% (average 34%) and surface rock is low. Pit depths are from 24 to 33 inches (average 29) and rooting depths range from 24 to 30 inches (average 26). Stands within this association occur in positions that receive run-on or percolation water. Roadcuts in these areas often have evident seepage. Generally, this association indicates a relatively warm, moist environment for tree growth with well-watered and drained soils.

VEGETATIVE COMPOSITION:

PIPO or PSME is present in all stands and both are often present. One of these two species dominates in all but one stand. POTR is present with low cover in two stands (probably indicating high moisture) and PICO occurs in one stand. LAOC occurred once in the samples, but many stands are outside of its geographic range. PIPO is often present in the regeneration layer with 1% cover, but PSME is more common and usually dominates. Overstory tree cover averages about 59%.

SYAL often forms a dense, knee-high understory; creating a distinctive appearance. SYAL is present in all stands, usually with coverages over 40% and sometimes as high as 80%. AMAL is 60% constant but averages only 2% cover. PAMY, ROSA, SASC, BEAQ and SPBEL are often present, but usually have less than 5% cover. The ROSA species including ROSA, ROGY and ROWO, may exceed 10% cover in some stands.

CARU is the most common herbaceous species with 80% constancy, but it exceeds 5% cover only once with 55%. OSCH occurs in 80% of the stands with 2% mean cover. ACMI, ARCO and FRAGA are present in about one-half of the stands sampled; ARCO is the most abundant. LUNA2 occurs in only 27% of the stands, but averages 7% cover where found.

INDICATORS:

A dense stand of SYAL on moderate slopes generally separates this type from any other on the Forest. The presence of SYOR or increasing slope steepness with increasing LIRU, BASA and AGSP indicate a transition to the more xeric PSME/SYOR type. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

Relative timber productivity is twice the 36 cu. ft/ac/yr average for the PSME series. This is the most productive site in the PSME series. Site indexes for PSME and PIPO are higher than for any other PSME series type. Total basal area at 196 sq. ft/ac is higher than every PSME series type except PSME/PAMY.

Herbaceous production is fair, averaging 66 lbs/ac, well below the 104 lb/ac average of the PSME series. Dense tree canopies and high shrub cover apparently account for the low herbage on this type.

PIPO dominates the overstory in more stands than PSME, but this trend is reversed in the regeneration layers. Periodic fire retards succession by maintaining PIPO when it would normally be excluded. Most of the shrubs, including SYAL, resprout following fire. The few fire scars present suggest that fire in these stands was relatively infrequent historically.

SILVICULTURE:

PSME or PIPO do well in this type. Data on other species is too limited to recommend them. Regeneration of harvested stands should be prompt to avoid shrub competition. Dwarf mistletoe was uncommon in the PSME.

RANGE MANAGEMENT:

This association is often heavily grazed because of gentle slopes and proximity to water. This site has good potential for water developments. Standard pasture grasses are suitable for seeding but heavy shrub cover will limit production. Cattle often congregate in these sites seeking shade and water.

COMPARISONS:

Daubenmire and Daubenmire (1968) in eastern Washington and northern Idaho, Pfister and others (1977) in Montana, and Brayshaw (1965) in British Columbia, all describe PSME/SYAL associations that are similar to ours. The AGSP phase of Pfister and others (1977) seems to better fit our PSME/SYOR association than our PSME/SYAL.

PRODUCTIVITY ESTIMATES

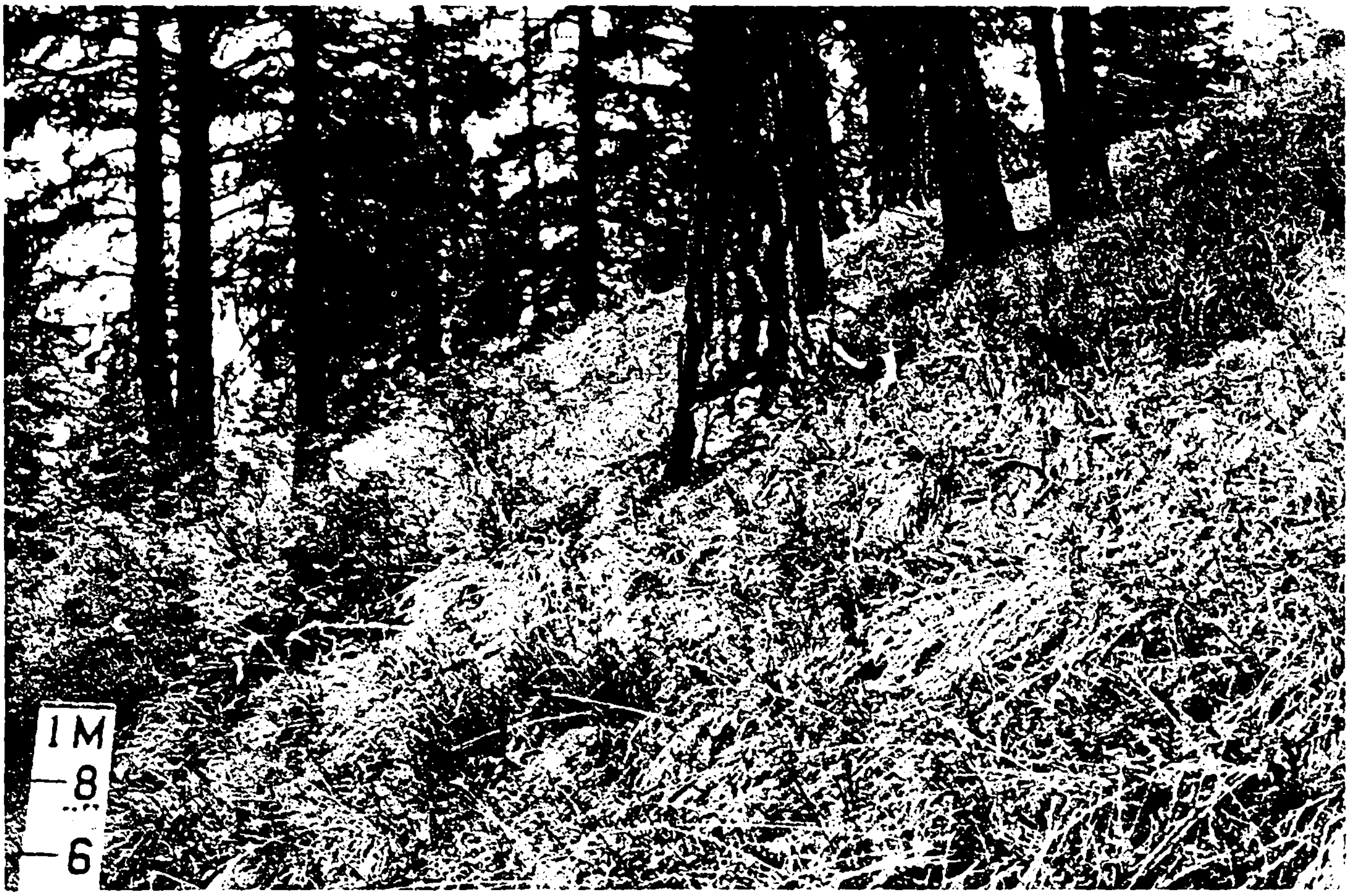
Plots = 5

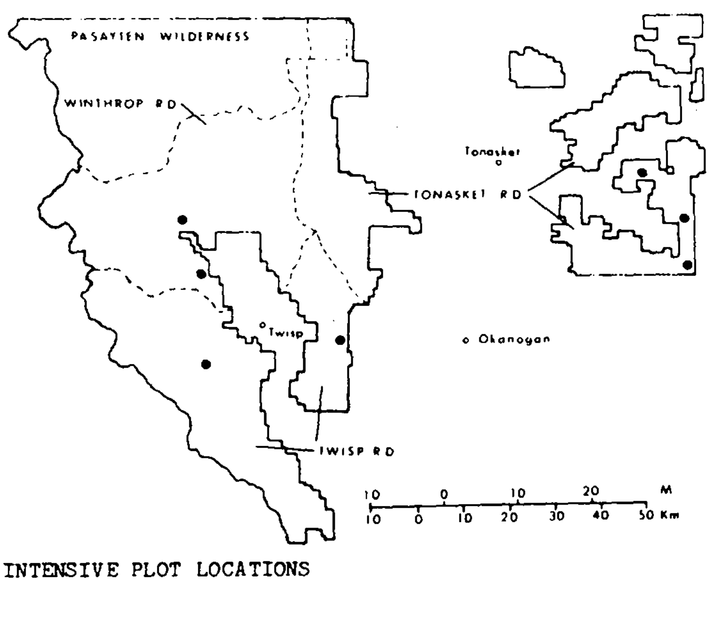
	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	66	0-115	58	18.3
TBA (sq. ft/acre)	196	143-251	60	21.8
STAND DENSITY INDEX (SDI)	310	187-362	88	31.8
SDI GROWTH EST (cu. ft/ac/yr)	72	33- 87	29	10.3

SPECIES (# plots)		SITE INDEX Mean	5%CI	SE	GBA/10 Mean	5%CI	SE	GBA-SI GROWTH EST. Mean	5%CI	SE
PSME (5)		98	11	4.0	314	59	21.4	153	28	10.0
PIPO (5)	82*	100	10	3.5	258	63	22.7	129	36	13.1

* Site index adjusted to a base 100 scale.

PSME/SYOR (OKAN) ASSOCIATION CD-S6-32
Pseudotsuga menziesii/Symphoricarpos oreophilus
Douglas-fir/mountain snowberry





INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts of the Forest. Elevations range from 2,310 to 5,240 feet (average 3,622). Aspects are east to west, but are generally southerly. Most slopes are steep, ranging from 19% to 63% (average 51%). Slope position is usually midslope, but ranges from upper to lower 1/3 with variable microrelief. Soils have variable parent materials but are always formed in colluvium or till; most often with sandy loam to sand textures, but occasional silt loam to silty clay loams textures occur in some soils.

Coarse fragments range from 26%-60% (average 42%) with surface rock of 1% to 20% (average 8%). Pit depths were from 23-52 inches (average 36) and rooting depths ranged from 21-52 inches (average 32). This association indicates a warm, relatively dry environment, with many stands adjacent to non-forested openings.

The PSME/SYOR association, as presently defined, is a composite of steep sites (slopes greater than 30%) with SYAL and areas where SYOR is the primary shrub species. The separation of sites with slopes over 30% from the PSME/SYAL association into the PSME/SYOR association is not made on species composition as much as on differences in productivity and management interpretations.

VEGETATIVE COMPOSITION:

PSME dominates the overstory of most stands, but PIPO may dominate or serve as a major component of the overstory. PICO is absent from this type. LAOC is present with low cover in only three stands. PSME is the most prevalent tree in the regeneration, occurring in 85% of the stands, while PIPO is in only 31%. Mean overstory tree cover is about 47%.

Because this association is a composite, SYAL or SYOR are in every stand, but AMAL is the single most constant shrub with 77% constancy but only 4% average cover. SYAL and SYOR occur in 69% and 31% of the stands with 38% and 16% cover, respectively. PAMY and BEAQ each have 38% constancy, with 4% and 6% mean cover, respectively.

CARU is the most common herb with 85% constancy and 9% mean cover. ACMI and COPA occur with low cover in 62% of the stands. No other species are present in over half the stands. BASA and LUSE occur in only 31% of the stands, but average 15% and 8% mean cover, respectively.

INDICATORS:

SYOR or SYAL on steep slopes are indicative of this association. The type often inhabits relatively dry colluvial slopes underlain by glacial till. SYOR generally indicates cooler growing conditions than SYAL. Decreasing SYOR, AGIN, BASA, PUTR, LIRU and LOTR with gentle slopes indicate a transition to the PSME/SYAL association. A general increase in understory cover, creating a change in the appearance of the community helps indicate a change toward PSME/SYAL. Slightly more mesic sites adjacent to PSME/SYOR are often the PSME/CARU types. Increasing CARU and decreasing SYAL and SYOR indicates this trend.

Increase in AGIN and BASA and decreasing tree cover indicates a trend toward non-forest openings. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

Relative timber productivity by SDI estimate at 31 cu. ft/ac/yr is just below the PSME series average of 36 cu. ft/ac/yr. Site index is relatively high for PIPO and PSME, but stand basal areas are low. Herbaceous production is 110 lbs/ac, just over the 104 lbs/ac average for the PSME series. Stands within this association have more herbaceous production than the PSME/SYAL association, perhaps because of lower stand basal areas and generally lower shrub cover.

SUCCESSIONAL RELATIONSHIPS:

PSME dominates the overstory in most stands, but PIPO is often a dominant or co-dominant. PSME also dominates the understory, indicating a trend toward PSME dominance in all stands. Logging generally retards successional development by favoring PIPO regeneration. Three out of seven intensive plots have fire scar information and suggest a fire frequency of 10-30 years. Burning increases the amount of CEVE and SHCA.

SILVICULTURE:

Sites are reasonably productive, but regeneration may be difficult. Coarse colluvial soils provide deep moisture for established trees and shrubs, but little for regeneration. Stands below 5,000 feet are suitable for PIPO or PSME, but on those below 3,000 feet, PIPO is suggested. Planting is necessary to assure regeneration and should follow soon after harvesting. Shading to protect seedlings from direct insolation may be necessary. Delay in tree establishment may create treeless areas, thereby extending adjacent openings into what was once forested land. Dwarf mistletoe may be a problem in PSME.

RANGE MANAGEMENT:

Reduction in tree canopy will increase herbage production. Heavy grazing tends to eliminate CARU with LUNA2 being a major increaser in sandstone derived soils. PUTR planting may be successful on sites below 4,500 feet elevation. Standard pasture grasses are suitable for seeding. Moderate to heavy livestock use is common.

COMPARISONS:

Reed, 1969 and 1976, describes a PSME/SYOR association for the Wind River mountains of Wyoming that is similar to ours. Pfister and others (1977) give a brief description of a few stands they called PSME/SYOR in Montana and reference them to work done in central Idaho by Steele and others (1981), who describe a PSME/SYOR association that resembles our plots with SYOR. Steele and others describe it as "... an overlap of Pseudotsuga forest and mountain shrub communities." This description well fits some of our sites. Their sites have less CARU and contain some species we do not have. They also have SYOR phases of other associations. Additionally, they have a PIPO/SYOR association that is similar to one of our plots. However, SYOR is present in many other associations in their area, a situation not duplicated in ours.

PRODUCTIVITY ESTIMATES

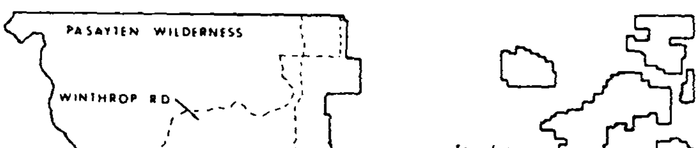
Plots = 7	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	110	16-265	98	39.9
TBA (sq. ft/acre)	112	78-173	31	12.7
STAND DENSITY INDEX (SDI)	189	107-311	63	25.9
SDI GROWTH EST (cu. ft/ac/yr)	31	18- 70	17	6.8

SPECIES (# plots)	SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
	Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (3)	82	13	4.9	136	30	11.6	56	13	5.1
PIPO (4)	80	11	3.6	114	55	17.4	46	26	8.2

PSME/PAMY (OKAN) ASSOCIATION CD-S4-11

Pseudotsuga menziesii/Pachistima myrsinites

Douglas-fir/pachistima



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found only on the Twisp and Winthrop Districts. No stands were found east of the Methow River. The association is best developed in the Twisp River drainage, but is also in the Methow River drainage. Elevations range from 2,400 to 4,160 feet (average 2,911) on all aspects. This is the lowest elevation association on the Forest. Slopes are moderate, ranging from 15% to 35% (average 28%). Slope position is usually mid to lower 1/3 on flat, concave or convex microrelief. Most soils are formed in sandstone alluvium and have sandy loam to sand textures. Coarse fragments range from 45% to 54% (average 49%) and surface rock from 1% to 15% (average 9%). Pit depths are from 15 to 35 inches (average 28) and rooting depths range from 15 to 35 inches (average 24). This association is one of the warmest on the Forest, but moisture is sufficient to provide excellent timber productivity. Stands often occur on highly dissected terraces, with a lot of surface litter.

VEGETATIVE COMPOSITION:

PSME dominates the overstory of most stands, but PIPO may dominate or serve as a major component. Except for small amounts of POTR, no other trees were present in the overstory. PSME is usually the only tree present in the understory, and occurred in all but one stand. Mean overstory cover is about 52%.

PAMY and SPBEL occur in every stand with 20% and 10% cover, respectively. AMAL has 87% constancy and 5% mean cover. SYAL is present in slightly less than half of the samples, but has 17% mean cover.

CARU is the most common herbaceous species averaging 10% cover in 80% of the samples. ASCO, GOOB, and LULA all occur in just under one-half of the stands with less than 5% cover.

INDICATORS:

The occurrence of PAMY over one foot in height in quantities over 5% cover separates this type from most others on the Forest. The large stature of PAMY (often exceeding two feet in height) is in marked contrast to the "normal" inconspicuous appearance of this shrub elsewhere on the Forest. The presence of ABLA2 or PIEN indicate a site that better fits the ABLA2/PAMY association. Increases in PYSE, CHUMO and VAME also indicate a transition toward ABLA2/PAMY association. Reduction in the size and cover of PAMY with decreasing SPBEL and SYAL indicates a transition toward the PSME/CARU association. Figure 7 portrays the relationship of this association to others on the Forest.

PRODUCTIVITY:

With 64 cu. ft/ac/yr, by SDI estimate, the relative timber productivity is nearly twice the 36 cu. ft/ac/yr average for the PSME series. The tree stratum of this association often has a scruffy appearance (perhaps due to spruce budworm activity) and may give an impression of low productivity. Site indices are not especially high, but total basal area and stand density index are the highest in the PSME series. The herbaceous production of 27 lbs/ac is low when compared to the 104 lbs/ac average for the PSME series. Herbaceous production will probably not improve much with overstory removal because of the high shrub cover.

SUCCESSIONAL RELATIONSHIPS:

PSME dominates most stands with PIPO the only other tree normally present. PSME is usually the only species present in the regeneration, clearly indicating a trend toward PSME climax. Two of six intensive sample stands show evidence of ground fires. Stand structures suggest that fire is essential for maintaining PIPO in this association. The dense stocking and relatively even-age characteristics of the stands indicate that crown fires are more frequent here than in most other associations in the PSME series. Shrubs common to to the association resprout following burning.

SILVICULTURE:

Stands are hot and dry in the summer and shade for regeneration is recommended. Stocking rates for PSME are high. PIPO or PSME may be used for regeneration. Shrub competition can be a problem if sites are not quickly reforested. Spruce budworm damage was still evident during sampling. Some slopes are steep and soils erosive, so specialized logging methods may be required. Observations suggest a relationship in this association with the occurrence of Armillaria mellea root rot. This relationship requires further study to be conclusive.

RANGE MANAGEMENT:

Grazing potential for livestock under natural stand conditions appear limited because of low forage production. Deer use is high based on the high number of trails and beds found in the sample plots. Standard pasture grasses are suitable for seeding.

COMPARISONS:

This association has not been reported by other workers in the Pacific Northwest. Daubenmire and Daubenmire (1968) used PAMY in some of their association names, but the PAMY associations they described are much different from ours. Hoffman and Alexander (1980) describe a PSME/PAMY association in Colorado that bears little resemblance to our type.

PRODUCTIVITY ESTIMATES

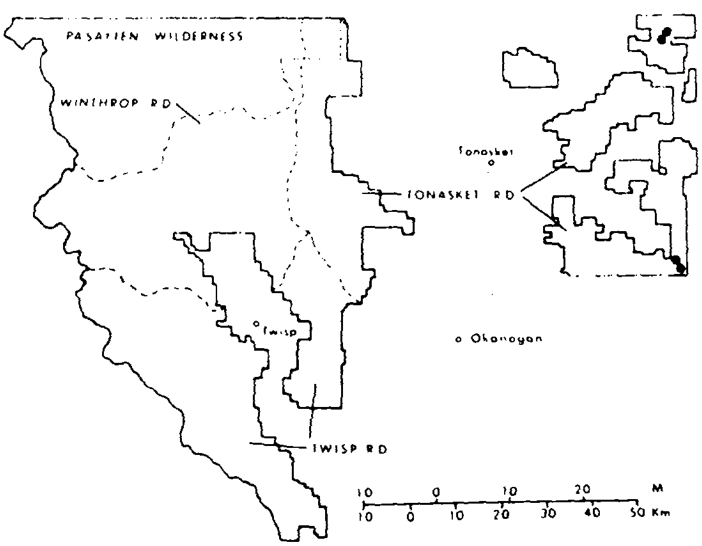
Plots = 6	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	27	10- 65	21	8.2
TBA (sq. ft/acre)	224	147-303	64	24.9
STAND DENSITY INDEX (SDI)	379	234-532	107	41.6
SDI GROWTH EST (cu. ft/ac/yr)	64	33- 95	29	11.1

SPECIES (# plots)	SITE INDEX Mean	SITE INDEX 5%CI	SITE INDEX SE	GBA/10 Mean	GBA/10 5%CI	GBA/10 SE	GBA-SI GROWTH EST. Mean	GBA-SI GROWTH EST. 5%CI	GBA-SI GROWTH EST. SE
PSME (6)	86	13	4.9	225	80	31.2	100	49	19.1
PIPO (3)	88	31	7.3	183	41	9.5	81	32	7.5

PSME/PHMA (OKAN) ASSOCIATION CD-S7-15

Pseudotsuga menziesii/Physocarpus malvaceous

Douglas-fir/ninebark



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is on the eastern part of the Tonasket Ranger District. This is the western extension of a widespread association farther east in the Rocky Mountains. Consequently, our data may not be representative of the type as a whole. Only four stands were intensively sampled. Elevations range from 2,240 to 4,040 feet (average equals 3,005 feet). The lowest elevation stands are on the west fork of the San Poil River. Aspects are variable and slopes normally steep, ranging from 7%-75% (average 41%). This association occurs on all slope positions with various microrelief. Soils are derived from various parent materials, but are coarse textured sands or loamy sands with some silt loams because of volcanic ash. Coarse fragments are higher than for any other PSME association, ranging from 45%-54% (average 49%) and surface rock is from 1%-15% (average 9%). Pit depths are from 13-23 inches (average 19) and rooting depths range from 13-21 inches (average 18). Elevations and soil temperatures indicate warm environmental conditions. The high coarse fragments allow water movement deep into the soil making plants go deep for moisture.

VEGETATIVE COMPOSITION:

PSME dominates the overstory of most stands, but LAOC occasionally dominates and occurs in nearly all plots. PSME is usually the only tree present in the understory. Mean overstory cover is about 52%. PHMA occurs in most stands with a mean cover of 24%. SPBEL occurs in 82% of the samples, with mean cover of 13%. AMAL and ROSA have constancies of 73%, but coverages under 5%. ARUV and SYAL have 5% or less cover with constancies of 64% and 55%, respectively.

CARU is the only herbaceous species that occurs in every stand, and at 32% mean cover also has the highest cover. Other herb species present in most stands include FRAGA, ANRA, ARCO and DITR, though coverages are generally low.

INDICATORS:

The occurrence on the east side of the Forest of more than 5% HODI or the presence of PHMA separates this association from all others on the Forest. PHMA is at the western edge of its range on the east half of the Tonasket District, and so is not found elsewhere on the Forest. Increasing ARCO and PAMY and decreasing PHMA, HODI, ARUV and SYAL indicates transition to the PSME/CARU association. Figure 7 portrays that relationship of this association to others on the Forest.

PRODUCTIVITY:

Relative timber productivity of the four stands sampled averaged just below the 36 cu. ft/ac/yr mean for the PSME series. Herbaceous production is about 40 lbs/ac below the 104 lbs/ac average for the PSME series.

SUCCESSIONAL RELATIONSHIPS:

PSME dominates most stands, with LAOC the only other species usually present. PSME dominating the regeneration clearly indicates a trend toward eventual dominance. Fire was not evident in any of the intensive samples. Daubenmire and Daubenmire (1968) noted that repeated burning reduces shrub cover and increases CARU. The shrubs will resprout if burning is not too frequent or severe. High SPBEL cover indicates past disturbance. Most forms of disturbance lead to an increase of shrub cover.

SILVICULTURE:

Stands are steep and soils usually high in coarse fragments. PSME and LAOC can be grown, but regeneration of LAOC may be difficult because of the warm, dry conditions. Heat and moisture stress should be anticipated. Severe regeneration problems have been common in PHMA stands on the Colville National Forest. (Potential is high for rodent damage to seedlings.) The shallow, rocky soils increase planting difficulty and are susceptible to displacement by heavy equipment. Dwarf mistletoe is common and infestation may be heavy on both PSME and LAOC. Studies of this association in the Rocky Mountains by Steele and Geier-Hayes (1983) indicate severe regeneration problems; contour trenching followed by planting is the only treatment consistently successful in establishing regeneration in their study.

RANGE MANAGEMENT:

Shrub cover reduces the amount and availability of herbage for cattle. Several of the common shrubs such as AMAL, ROSA and ACGLD are good for deer browse, and the tall shrub layer is excellent hiding cover.

COMPARISONS:

Associations with PSME as the major tree species and PHMA as the primary shrub have been widely reported for areas in the Rocky Mountains. Daubenmire and Daubenmire (1968) in eastern Washington and northern Idaho, Hall (1973) in northeastern Oregon, Pfister and others (1977) in Montana, Steele and others (1982) in central Idaho, all have published reports of PSME/PHMA associations. Some workers, notably Pfister and others (1977) and Steele and others (1981), have subdivided the basic association into subtypes based upon differences in floristics. Inasmuch as our data is from the western range extension of PHMA, our data does not fit many of their subdivisions. Later work on the Colville National Forest will help solve some of these questions.

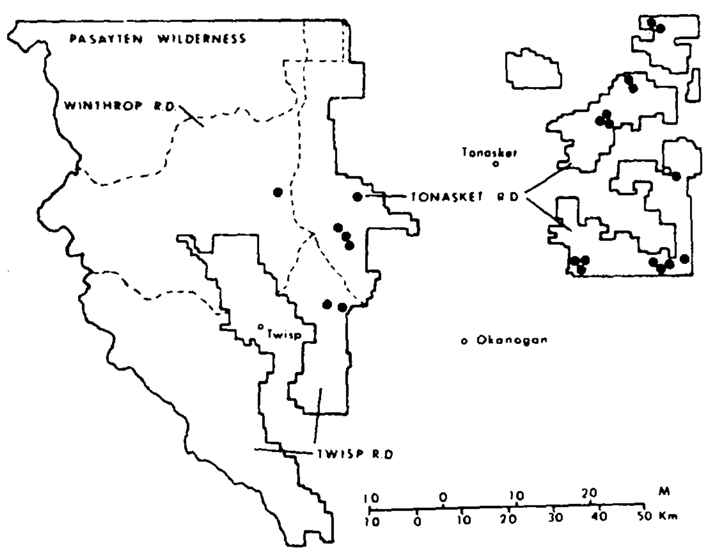
PRODUCTIVITY ESTIMATES

Plots = 4	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	71	5-171	114	36.0
TBA (sq. ft/acre)	158	114-192	62	19.4
STAND DENSITY INDEX (SDI)	268	109-360	174	54.7
SDI GROWTH EST (cu. ft/ac/yr)	31	14- 44	20	6.2

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (4)		73	5	1.5	166	35	11.0	60	10	3.1
LAOC (1)	81*	50	**	**	134	**	**	54	**	**

* Site index adjusted to a base 100 scale.
** Indicates data insufficient to calculate statistics.

ABLA2/VACCI ASSOCIATION CE-S3-12
Abies lasiocarpa/Vaccinium
subalpine fir/huckleberry



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts, but normally east of the Methow River. Elevations range from 3,480 to 5,720 feet (average 4,390) and aspects are variable. Most slopes are moderate, ranging from 1% to 59% (average 24%). Slope positions are usually either ridgetops or lower 1/3 and bottoms with flat or concave microrelief. Soils are often mottled and are derived from various parent materials. Most are formed in glacial till, outwash, or alluvium with silt loam to sand textures. Silt loam textures are a result of ash surface horizons. Coarse fragments range from 6 to 37 percent (average 20%) and surface rock from 0% to 3% (average 1%). Pit depths are from 20 to 58 inches (average 35) and rooting depths range from 15 to 50 inches (average 26). This association indicates cool and moist growing conditions.

VEGETATIVE COMPOSITION:

LAOC, PSME, and PICO are the most common canopy species with 86%, 83% and 78% constancy, respectively. One or more of these three species dominate all but 5 of thirty-one sample stands. ABLA2 or PIEN are present in the overstory of one-half or more of the stands and they dominate the few stands not dominated by LAOC, PSME and PICO. PSME, ABLA2 and PIEN are the major regeneration species. PSME is more prevalent in the regeneration in about half of the samples, while ABLA2 and/or PIEN dominate most of the others. Mean overstory tree cover is about 61% in this association.

This is a shrub-rich association, most of which are low in height. No shrub occurs in all stands, but many shrubs occur in over half of the stands, including LIBOL, ARUV, PAMY, CHUMO, PYSE and VASC. The Vacciniums as a group occur in every stand and are frequently the most abundant species, with over 15% cover. LIBOL averages 15% cover, and VASC and VAMY 17% and 18%, respectively.

CARU is the most common and abundant herbaceous species with 72% constancy and 21% mean cover. CACO and FRAGA are the only other herbs present in more than half the samples and they have 5% or less mean cover.

INDICATORS:

Presence of ABLA2 and/or PIEN with VACA or other Vaccinium species and LIBOL generally separate this association from all others on the Forest. The presence of Vaccinium species, ABLA2 and PIEN indicate cool and often frosty growing conditions. The general lack of PIPO also suggests this. Reduction in ABLA2 and PIEN reproduction and decreasing soil depth suggest a transition to the slightly warmer and drier PSME/VACCI association. Reduction in Vaccinium species and ARUV indicates transition to the ABLA2/LIBOL association. Increasing VASC cover indicates a transition to the cooler, more frosty ABLA/VASC/CARU association with corresponding lower timber productivity. Presence of VASC indicates that timber productivity is decreased by 10% to 20%.

PRODUCTIVITY:

SDI timber productivity estimate of 58 cu. ft/ac/yr is just above the 50 cu. ft/ac/yr average for the ABLA2 series. This association is one of the more productive upland types in the ABLA2 series. The warmer ABLA2/LIBOL is considerably more productive, however, suggesting that cold may limit growth. The relatively few coarse fragments, good soil depth, and frequent soil mottles suggest water is usually available. Mottles indicate too much water for at least part of the growing season, either reducing soil temperatures and/or soil aeration. Herbage production is only about 30% of the 132 lbs/ac average for the ABLA2 series. Heavy grazing may have reduced the herbage figure.

SUCCESSIONAL RELATIONSHIPS:

Stand age structure indicates that although ABLA2 may not dominate the reproduction, it is the most shade tolerant species, capable of growing on the sites and will eventually displace species such as LAOC, PICO and PSME in the absence of disturbance. PIEN appears capable of maintaining itself in conjunction with ABLA2.

Most stands sampled are in mid to lower seral stages where ABLA2 is just gaining presence in the overstory. The few fire scars examined and stand structures suggest fire has played an important role in maintaining seral tree species in most stands. PIEN and ABLA2 are usually younger than the other tree species present. Continued fire suppression favors PIEN and ABLA2. Logging will generally favor regeneration of the seral species.

SILVICULTURE:

The major limitation appears to be cool temperatures that retard growth and frost that damages seedlings. Frost is generally a result of cold air concentrations, rather than reradiation cooling. Care should be taken to avoid creating frost pockets through tree harvest. Reforestation should be prompt to minimize competition with CARU and other vegetation. Dwarf mistletoe is present in most stands and infestation may be heavy.

Mottling in soil profiles indicates high water tables at least part of the year. Removal of trees may raise the water table to the point that a swampy situation is created with attendant difficulties in reforestation.

RANGE MANAGEMENT:

Gentle slopes and close proximity to water make these stands susceptible to overgrazing (most plots show moderate to heavy grazing). Standard pasture grasses and clovers are applicable for reseeding. Gentle slopes and the presence of the rhizomatous CARU reduce the need for erosion control seedings.

COMPARISONS:

Pfister and others (1977) in Montana, and Steele and others (1982) in central Idaho, describe an ABLA2/VACA association. However, their sites appear more severe than ours. In theirs, PICO is the major conifer present, apparently because of frost. In our areas, VACA is more sporadic in distribution, being more common east of the Methow River drainage than west. Our stands contain larger amounts of PSME, PIEN, ABLA2 and LAOC than theirs, and less PICO. Additionally, our environmental conditions appear less severe.

PRODUCTIVITY ESTIMATES

Plots = 22	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	44	0-198	25	12.1
TBA (sq. ft/acre)	198	153-312	19	9.3
STAND DENSITY INDEX (SDI)	404	233-653	55	26.4
SDI GROWTH EST (cu. ft/ac/yr)	58	28-106	10	4.7

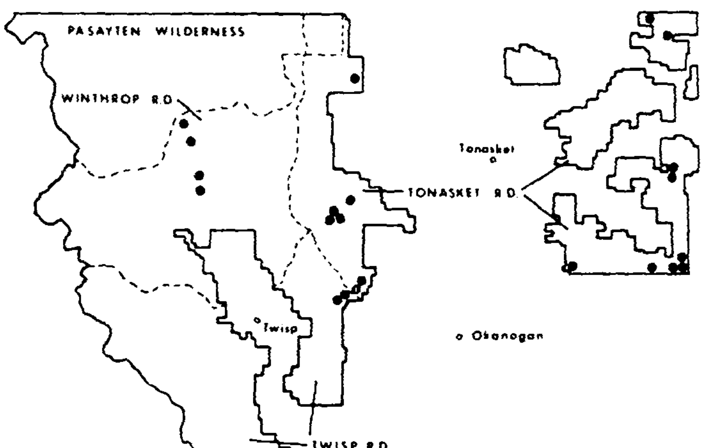
SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
LAOC (16)	93*	57	4	1.7	173	24	11.1	80	14	6.7
PSME (15)		79	4	2.0	211	40	18.8	84	17	8.0
PICO (14)	79*	46	4	1.9	173	25	11.5	67	14	6.4
ABLA2 (5)		90	14	5.0	184	46	16.7	84	33	11.8
PIEN (5)	90*	54	14	5.1	180	30	10.9	80	14	6.7

* Site index adjusted to a base 100 scale.

ABLA2/LIBOL (OKAN) ASSOCIATION CE-F2-11

<u>Abies lasiocarpa/Linnaea borealis var. longiflora</u>

subalpine fir/twinflower



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts of the Forest, and is the most widespread association in the ABLA2 series. Elevations range from 2,170 to 5,940 feet (average 4,536) and aspects are variable. Most slopes are moderate, ranging from 1% to 59% (average 24%). Slope position is usually from midslope to bottom with flat to concave microrelief. Soils are derived from mixed parent materials, normally in glacial or fluvial material with silt loam to sand textures. The silt loam is generally a result of the volcanic ash influence in the surface horizons. Some clay loam textures were also found indicating good moisture movement through the profiles where found. Ground water was encountered in several pits. Coarse fragments range from 10% to 77% (average 35%) and surface rock ranges from 1% to 15% (average 2%). Pit depths are from 12 to 50 inches (average 29) and rooting depths range from 10 to 36 inches (average 20). This association indicates a relatively moderate, moist environment which is also suggested by the high timber productivity figures. This is the most productive association in the ABLA2 series.

Older stands often have very heavy shade which reduces shrub and herb cover and species composition. Litter is the major ground cover. One-third of the plots representative of the association are in such stands; hence, species composition is more variable than for most other plant associations.

VEGETATIVE COMPOSITION:

PIEN is the most common and abundant overstory species, with 83% constancy and 22% mean cover. PSME and ABLA2 have 76% and 70% constancy, respectively, with about 20% mean cover. LAOC and PICO are the only other species normally present, with just over 50% constancy (PIPO is essentially absent). Overstory tree cover averages 62%. PIEN is the most consistent species in the understory, but ABLA2 is the most abundant when present. PIEN and ABLA2 regeneration have constancies of 74% and 65%, and mean coverage of 4% and 11%, respectively. PSME occurs with low cover in less than 50% of the stands.

Many shrubs occur in this association, but only four (PYSE, PAMY, LIBOL and CHUMO) have over 50% constancy. PYSE is more constant, but has such low cover and stature as to be inconspicuous. LIBOL cover averages 11%. Vacciniums as a group are much less common in this association than in ABLA2/VACCI.

No herbaceous species occur in over half of the stands, but THOC, ARCO, OSCH, CARU and GOOB are the most common.

INDICATORS:

The presence of ABLA2 and LIBOL with only small amounts of ARUV and Vacciniums distinguish this association from all others in the study area. Increasing ARUV and Vaccinium species indicate a transition to the ABLA2/VACCI association. Lack of ABLA2 and PIEN reproduction and decreasing CHUMO, COST, PYSE, OSCH and THOC with increasing PIPO, CARU and ARUV indicate a transition to the PSME/VACCI association. Stands with Vaccinium species appear to be slightly lower in timber productivity. Conversely, stands without Vaccinium species, but with high cover of LIBOL, appear somewhat higher in productivity. Vacciniums indicate cooler temperatures and an increasing potential for frost. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

SDI timber productivity estimate at 92 cu. ft/ac/yr is nearly twice the 50 cu. ft/ac/yr average for the ABLA2 series. Adequate moisture and moderate temperatures result in the highest productivity of any association on the Forest. Site index for LAOC and PIEN are excellent and total basal area is high. Herbaceous production at 30 lbs/ac is less than 25% of the mean for the ABLA2 series. Herbage production is low because of the dense shade common in natural stands. Overstory removal will increase herbaceous production.

SUCCESSIONAL RELATIONSHIPS:

PSME or PIEN dominate the overstory in about half the stands, with ABLA2, LAOC or PICO dominating in others. Generally, ABLA2 and PIEN dominate tree reproduction, indicating a trend toward an ABLA2 and PIEN domination without disturbance. ABLA2 is more shade tolerant but PIEN is longer lived and more disease resistant.

Fire frequency is relatively low in this association, but nearly all stands do have evidence of past fire. The few stands dominated by ABLA2 suggest fire encourages regeneration of LAOC, PICO and PSME. Repeated fires lead to nearly pure stands of PICO. Based on observations of stand structures and composition, a common seral sequence following a fire is for LAOC, PICO and then PSME to establish, followed by PIEN and still later by ABLA2.

When PICO has died out in very old stands and then a fire comes through, the area normally has little PICO regeneration and LAOC often dominates the regenerating stand.

Maximum cover and species richness of the understory occurs when stands aren't too dense; often before PIEN forms a major part of the overstory. Dense pole-sized stands often shade out nearly all understory species.

SILVICULTURE:

These stands are moist, moderately cool and not generally prone to frost in natural stands. Harvesting may create frost pockets in some areas, depending on landform and cold air drainage patterns. Sites are cool enough to exclude PIPO in most cases, but nearly all other tree species on the Forest grow well here. Due to the high soil moisture on these sites, springs and seeps often appear following tree harvest because of reduced evapotranspiration. High soil moisture and fine soil textures make soil compaction a potential hazard. Shrubs and herbaceous species are quick to re-invade following logging, so reforestation should be prompt to avoid excessive competition with tree seedlings.

RANGE MANAGEMENT:

Forage for livestock is usually not abundant, but livestock use is moderate because of the gentle slopes and close proximity to water. Standard pasture grasses and clovers do well for reseeding, though some areas may require grasses suited to high soil moisture. In seeded areas, cattle may congregate because of the combination of gentle slopes, nearby shade, adequate water, and forage. This may result in soil compaction and reforestation problems. In many cases, gentle slopes preclude the need of seeding for erosion control.

COMPARISONS:

Pfister and others (1977) in Montana, and Steele and others (1982) in central Idaho, describe an ABLA2/LIBO association in their areas. Their associations are similar, especially in the LIBO phase of Pfister and others. Our sites often have more LAOC and less PICO than theirs, and less PIPO than the Montana data indicates. Some of our plots would fit within the ABLA2/PAMY association described by Daubenmire and Daubenmire (1968). Parts of the ABGR/LIBO forb type of Hall (1973) have some similarity to our type, but we lack ABGR in our area and so our sites appear to differ more from his association in Oregon than from the ABLA2/LIBO types in Montana and Idaho.

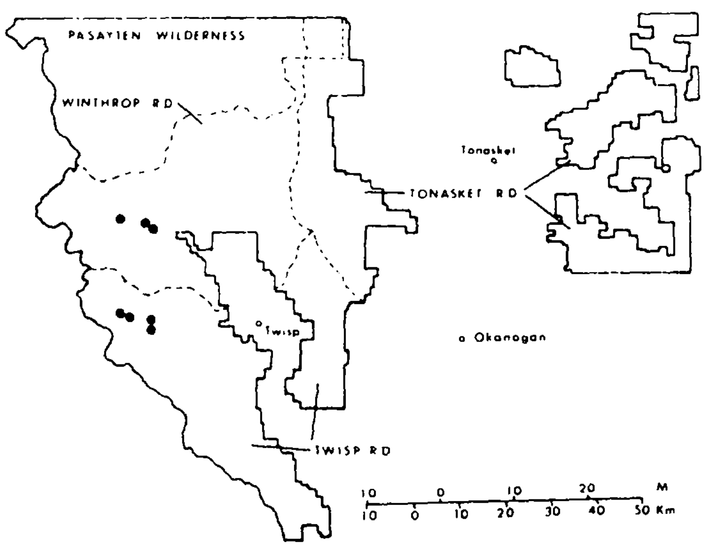
PRODUCTIVITY ESTIMATES

Plots = 22	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	30	0-149	16	7.7
TBA (sq. ft/acre)	238	148-379	28	13.6
STAND DENSITY INDEX (SDI)	443	280-885	59	28.2
SDI GROWTH EST (cu. ft/ac/yr)	92	62-137	11	5.3

SPECIES (# plots)		SITE INDEX Mean	5%CI	SE	GBA/10 Mean	5%CI	SE	GBA-SI GROWTH EST. Mean	5%CI	SE
PIEN (19)	95*	66	6	2.1	277	45	21.6	131	25	11.9
PSME (16)		86	6	3.0	250	34	15.8	107	14	6.7
LAOC (9)	110*	67	5	2.0	243	39	17.0	133	23	9.8
ABLA2 (12)		92	8	3.6	218	28	12.5	101	19	8.6
PICO (4)	79*	50	15	4.6	177	111	35.0	70	38	11.9

* Site index adjusted to a base 100 scale.

ABLA2/PAMY (OKAN) ASSOCIATION CE-S1-11
Abies lasiocarpa/Pachistima mysinities
subalpine fir/pachistima



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found only on the Twisp and Winthrop Districts and is best developed in the Twisp River drainage, but is also represented in the Methow River drainage. It has not been observed farther east than Range 20E, Willamette Meridian. Elevations range from 2,430 to 5,940 feet (average 4,390) and aspects are generally northerly. Most slopes are moderate, ranging from 3% to 61% (average 27%). Slope positions are usually midslope to bottoms and microrelief is variable.

Soils are normally derived from sedimentary glacial outwash with mainly silt loam to sand textures. Coarse fragments range from 5% to 55% (average 33%) and surface rock ranges from 1% to 2% (average 1%). Pit depths are from 23 to 35 inches (average 31) and rooting depths range from 21% to 35% (average 27%) with compacted horizons or cobbles usually limiting root penetration. This association had the highest recorded soil temperature in the ABLA2 series, yet moisture was sufficient to give the second highest productivity estimate in this series. Bare ground and litter are conspicuous between the shrubs and many stands exhibit a scruffy appearance, perhaps because of spruce budworm activity in recent years.

VEGETATIVE COMPOSITION:

PSME is the most common and abundant overstory species, with 97% constancy and 31% mean cover. PICO occurs in just over half of the stands, with 16% mean cover. PIPO has 42% constancy, with 8% average cover. ABLA2 and PIEN occur in the overstory of 35% of the sample stands, with mean coverage of 9% and 15%, respectively. Total overstory cover averages 51%. ABLA2 is the most common understory tree species. PSME and PIEN are often present but are less frequent and abundant than ABLA2.

PAMY dominates the shrub cover in every stand, with a mean cover of 27%. SPBEL is a common and abundant species, with 71% constancy and 10% mean cover. SASC, PYSE and VAME have 50% or more constancy, but usually have low cover values.

CARU occurs in 71% of the stands, with 12% mean cover; it and GOOB are the only herbs that occur in half or more of the stands. Other herbs are variable in amount and occurrence.

INDICATORS:

Robust PAMY with cover of 15% or more, with sufficient ABLA2 and PIEN to indicate ABLA2 climax separates this type from all others on the Forest. The large stature of the PAMY shrubs here and in the PSME/PAMY association is in marked contrast to the usual appearance of this shrub elsewhere on the Forest. Decreasing ABLA2, PIEN, Vaccinium species and GOOB, with increasing PIPO, suggests a transition to the warmer and drier PSME/PAMY association. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

SDI timber productivity estimate at 79 cu. ft/ac/yr is second highest in the ABLA2 series and well above the 50 cu. ft/ac/yr mean. PSME has a higher site index and GBA than anywhere else on the Forest. Herbage production is low at 28 lbs/ac when compared to the 132 lbs/ac average for the ABLA2 series. High shrub cover appears to limit herbage production.

SUCCESSIONAL RELATIONSHIPS:

Although PSME dominates the overstory in most stands, presence of ABLA2 and PIEN indicates a transition to these more competitive species through time. Fire scars are not common, suggesting that underburning is not as common here as in other associations. Based on the dense stocking and relatively even age of the trees, it appears that crown fires are more typical than low intensity underburns. Most shrubs present in the association readily resprout after burning.

SILVICULTURE:

This productive association is well suited to intensive timber management. High shrub cover may create regeneration problems if reforestation following harvest is not prompt. PSME is suggested for management. Many sites are too cool to use PIPO, but it may do well on warmer sites within the association. Limited observations along the Twisp River indicate that laminated root rot (Phellinus weirii) is common in the type. Steep slopes and soils with high coarse fragments are susceptible to displacement.

RANGE MANAGEMENT:

Standard pasture grasses are suitable for revegetation. Dense tree and shrub cover limit herbaceous production in natural stands. Areas that have been seeded following logging have a high cover of grass, so seeding to increase herbage is possible, if desired.

COMPARISONS:

Daubenmire and Daubenmire (1968) describe an ABLA2/PAMY association for eastern Washington and northern Idaho. Their association does not resemble our ABLA2/PAMY association. In their type, PAMY is uncommon and inconspicuous. Their stands contain species such as MEFE, XETE, LOUT and ANPI which are absent or rarely present in our stands. The ABLA2/CLUN association, with various phases as described by Pfister and others (1977), and Steele and others (1982) for Montana and central Idaho, also are not really comparable to our ABLA2/PAMY association. Their type is more similar to Daubenmire and Daubenmire's (1968) ABLA2/PAMY association.

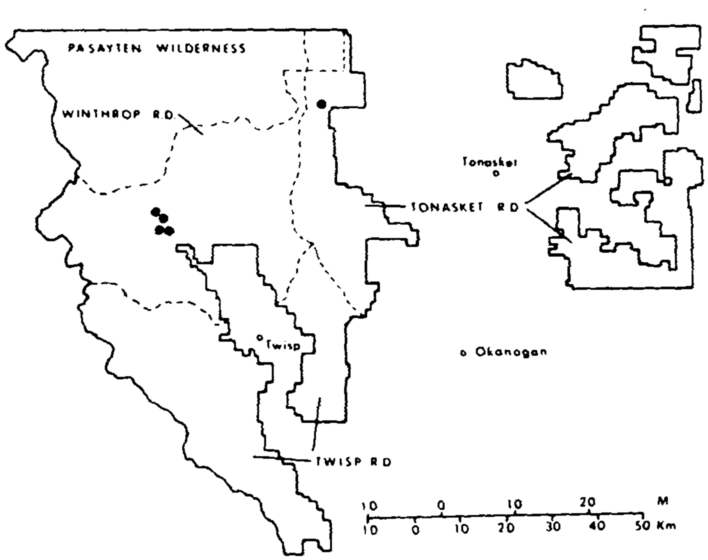
PRODUCTIVITY ESTIMATES

Plots = 7	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	28	0- 98	37	14.3
TBA (sq. ft/acre)	223	186-293	33	13.4
STAND DENSITY INDEX (SDI)	376	305-428	41	16.8
SDI GROWTH EST (cu. ft/ac/yr)	79	44-115	24	9.8

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (7)		102	14	5.9	268	65	26.5	138	45	18.5
PICO (1)	85*	50	**	**	238	**	**	101	**	**
PIPO (1)		83	**	**	103	**	**	43	**	**
ABLA2 (1)		85	**	**	138	**	**	55	**	**
PIEN (1)	129*	85	**	**	313	**	**	202	**	**

* Site index adjusted to a base 100 scale.
** Indicates data insufficient to calculate statistics.

ABLA2/VASC/CARU (OKAN) ASSOCIATION CE-S4-13
Abies lasiocarpa/Vaccinium scoparium/Calamagrostis rubescens
subalpine fir/grouse huckleberry/pinegrass



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts, but it is most common on the Winthrop District. Elevations range from 4,960 to 5,900 feet (average 5,253), and aspects are from east to west, but are generally southerly. Most slopes are steep, ranging from 25% to 60% (average 42%). Slope position ranges from ridgetop to lower 1/3, with variable microrelief. Soils are derived from sandstone or granitic glacial outwash and till, usually with sandy loam to sand textures. Soils often have a restrictive layer that limits rooting depth. Coarse fragments range from 27% to 72% (average 42%) and surface rock from 1% to 5% (average 3%). Pit depths are from 26 to 44 inches (average 33) and rooting depth from 14 to 38 inches (average 23). This association seems to characterize a frosty, yet relatively dry habitat within the ABLA2 series.

VEGETATIVE COMPOSITION:

PSME and ABLA2 are both present in the overstory of 88% of the samples, but PSME has 36% mean cover while ABLA2 has only 4% mean cover. PICO has mean cover of 15% in 75% of the samples. PIEN occurs in the overstory in only 25% of the stands, but has 20% mean cover when present. LAOC and PIAL are uncommon, and PIPO is absent. ABLA2 is consistent in the tree understory and usually is the most abundant. PSME and PICO are occasionally present, but are normally less abundant than ABLA2. PIEN has the highest average cover in the understory, but constancy is low.

No shrub is present in all stands. PAMY and SPBEL constancies approach 90%, but average cover is under 5%. VASC, VAME and VAMY all have constancies of 50% or more, and cover of one or more species exceeds 5% in the stands.

CARU is present in all stands and averages 33% cover. ANRA, ARCO, LULA, HIAL and CACO are present in most stands, and LULA and ARCO are normally the most abundant.

INDICATORS:

VASC with abundant CARU on steep slopes distinguish this association from the ABLA2/VASC and ABLA2/CARU associations. Decreasing *Vaccinium* species and THOC with continued high CARU cover indicates a transition to the more productive ABLA2/CARU association. Decreasing VAME and CARU with decreasing soil depth and increasing elevation indicates a transition to the colder ABLA2/VASC association. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

SDI timber productivity estimate of 23 cu. ft/ac/yr is lower than all but upper timberline associations within the ABLA2 series. Average site index for PSME is lower than all other associations, except some near timberline. The precise limiting factors to tree growth are not fully understood. Soils may be important due to restricted rooting depths on some sites. Frost may also be significant. Herbaceous production is excellent, averaging 426 lbs/ac, over three times the ABLA2 series average due in part to the high cover of LULA.

SUCCESSIONAL RELATIONSHIPS:

PSME dominates the overstory in most stands, with PICO the second most common overstory species. ABLA2 dominance of the reproduction indicates a trend toward an ABLA2 climax. No fire scar data are available for the association. Dwarf mistletoe in the PSME reduces its vigor and tends to hasten its replacement by the more shade tolerant ABLA2 and PIEN. High cover of LULA may indicate past heavy grazing. LUNA2 increases markedly on sandstone derived soils following heavy livestock grazing.

SILVICULTURE:

Frost pocket potential is high. Careful attention should be paid to local topography and air drainage. Herbaceous competition potential for young trees is high. Steep slopes and gravelly soils may require specialized logging to avoid excessive erosion. Data are limited, but growth potential of PIEN appears greater than PSME and PICO on one plot with deep granitic till derived soils. PIEN is poorly represented on soils with sandstone parent material and is not suggested on those sites.

RANGE MANAGEMENT:

This association is excellent for livestock grazing because of its high herbaceous production. Steep slopes may limit cattle movement and access to water. Use by deer, as indicated by trail frequency and pellets, is common.

COMPARISONS:

Pfister and others (1977) in Montana, and Steele and others (1982) in central Idaho, describe a CARU phase of their ABLA2/VASC association that appears similar to the ABLA2/VASC/CARU association, except that VASC coverage averages much more in their sites. Pfister and others (1977) description is especially fitting to our stands. McLean (1970) describes a CARU phase of his ABLA2/VASC association that appears the same as our plots with granitic soils. As a whole, McLean's type has more PIEN and ARUV than does ours.

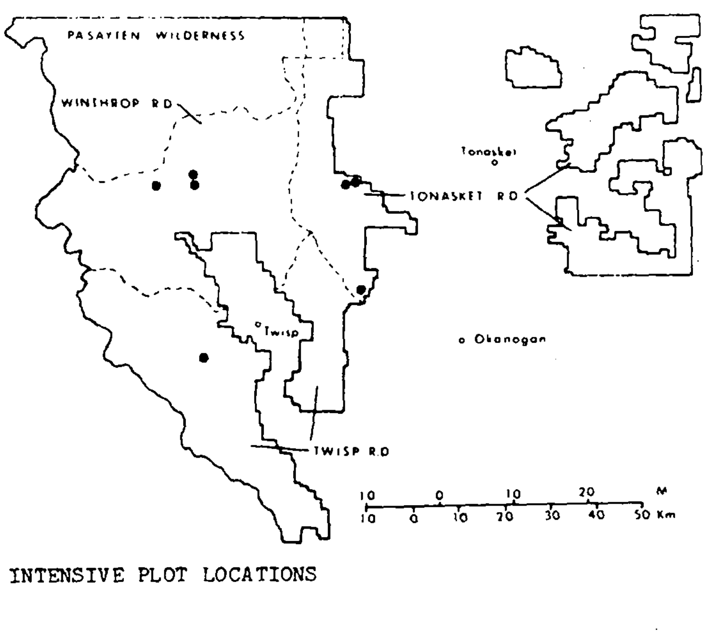
PRODUCTIVITY ESTIMATES

Plots = 5	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	331	77-532	211	76.1
TBA (sq. ft/acre)	169	107-216	55	19.7
STAND DENSITY INDEX (SDI)	284	210-372	84	30.3
SDI GROWTH EST (cu. ft/ac/yr)	23	17- 29	7	2.7

SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (5)		63	2	0.9	156	41	14.9	49	15	5.4
PICO (3)	60*	32	**	**	117	**	**	35	**	**
ABLA2 (1)		50	**	**	169	**	**	42	**	**
PIEN (1)	79*	55	**	**	179	**	**	71	**	**

* Site index adjusted to a base 100 scale.
** Indicates data insufficient to calculate statistics.

ABLA2/CARU (OKAN) ASSOCIATION CE-G3-11
Abies lasiocarpa/Calamagrostis rubescens
subalpine fir/pinegrass



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts of the Forest, but is most common on the Winthrop District. Elevations range from 4,800 to 5,740 feet (average 5,316). Aspects range from east to west, but are generally westerly. Slopes are steep, ranging from 25% to 60% (average 45%). Slope position is usually mid to upper 1/3 and stands occur on various microreliefs. Soils are derived from sandstone with sandy loam to sand textures. One soil had sandy clay loam texture. Coarse fragments range from 30% to 48% (average 39%) and surface rock from 0% to 4% (average 2%). Pit depths are from 18 to 52 inches (average 34) and rooting depths from 18 to 52 inches (average 28). This association seems to indicate cold, yet dry growing conditions. This is probably one of the driest sites in the ABLA2 series.

VEGETATIVE COMPOSITION:

PSME dominates the overstory of all but one stand. ABLA2 is usually present in the overstory, but dominates none of the samples. PICO was present in less than half of the stands, but occasionally dominates stands. LAOC is part of some stands, but PIPO is poorly represented. Overstory tree cover averages 54%. PSME is the most common and abundant understory species, but sufficient ABLA2 is present to indicate a trend toward increasing ABLA2 dominance.

PAMY and PYSE are the most common shrubs with 92% and 50% constancy, respectively. Both average 2% cover. No other shrubs are regularly present or abundant.

CARU is present in all stands with a mean cover of 39%. Forbs are conspicuous members of this association. ANRA, LULA, ARCO and ASTER are present on most sites and average over 5% cover. THOC is less frequently encountered, but is usually abundant when it occurs. GOOB was present in half of the samples, but averaged only 2% cover.

INDICATORS:

The presence on steep slopes of CARU, with ABLA2 the indicated climax without VACA or LIBOL, is typical of this association. Generally high forb cover with few or no shrubs separates this type from others with which it might be confused and gives this association a distinctive appearance. Decreasing ABLA2 with increasing LAOC and PIPO indicates a transition to the warmer and drier PSME/CARU or PSME/SYOR associations. Increasing VASC or VAMY indicates a transition to the ABLA2/VASC/CARU association. Figure 7 portrays the relationahip of this type to others on the Forest.

PRODUCTIVITY:

SDI timber productivity estimate of 55 cu. ft/ac/yr approximates the 50 cu. ft/ac/yr average for the ABLA2 series. This site is more productive than the ABLA/VASC/CARU possibly because of deeper soils and less frosty conditions. Herbaceous production is good, being nearly twice the 132 lb/ac mean for the ABLA2 series.

SUCCESSIONAL RELATIONSHIPS:

ABLA2 is the most shade tolerant tree found in the assocation, but it appears near its drought tolerance limits and does not show clear evidence of fully displacing PSME. PIEN is poorly represented, suggesting again the relatively xeric nature of the sites. Fire scars are present in nearly all plots, but are so grown over, they are difficult to analyze. The most recent scars are usually over 75 years old. Underburning appears to have been important in maintaining a structure of old growth PSME trees over a sward of CARU and assorted forbs.

SILVICULTURE:

Extremes in environmental conditions make regeneration difficult. Problems include steep westerly slopes, large diurnal temperature ranges, heavy CARU competition, droughty soils and winter kill by desiccation. Broadcast burning may increase potential for desiccation or heat damage because of the darkening effect on the soil, increasing surface soil temperatures in summer and causing earlier snowmelt in spring. Sites appear too cold for PIPO to do well. PSME appears to be the most dependable species for timber management. PICO and LAOC may be suited to some sites. Dwarf mistletoe is present in all samples and was heavy in some stands.

RANGE MANAGEMENT:

This association provides over twice the mean herbaceous production for the ABLA2 series. Steep slopes may limit cattle movement and access to water. Livestock use is usually moderate in the sample stands. LULA tends to increase with livestock grazing. LUNA2 increases on many sites following heavy grazing. Deer trails and pellets were common in most stands.

COMPARISONS:

Pfister and others (1977) in Montana describe an ABLA2/CARU association that is similar to ours, except their sites have more PICO and JUCO and contain CAGE. Steele and others (1982) in central Idaho also describe an ABLA2/CARU association, but their type appears more broadly defined than ours with more shrubs such as SYOR included, as well as containing less PSME and more ABLA2. Their sites also have large amounts of CAGE.

PRODUCTIVITY ESTIMATES

Plots = 7	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	253	39-598	207	84.5
TBA (sq. ft/acre)	230	176-304	40	16.3
STAND DENSITY INDEX (SDI)	366	292-489	66	27.1
SDI GROWTH EST (cu. ft/ac/yr)	55	44- 80	12	4.8

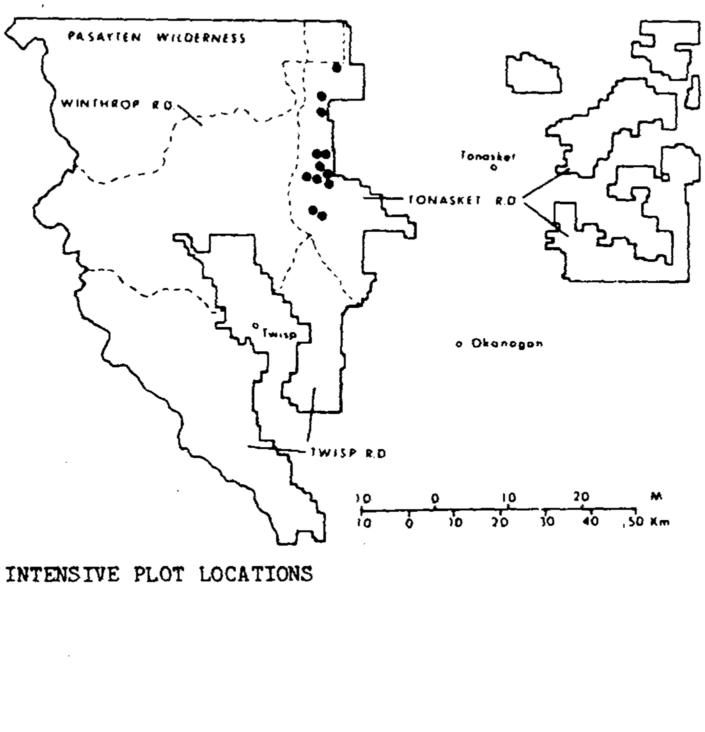
SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PSME (7)		82	9	3.6	207	30	12.3	85	17	6.8
PICO (3)	80*	48	**	**	201	**	**	80	**	**
LAOC (2)	96*	59	**	**	171	**	**	82	**	**
ABLA2 (1)		67	**	**	165	**	**	56	**	**

* Site index adjusted to a base 100 scale.
** Indicates data insufficient to calculate statistics.

ABLA2/VASC (OKAN) ASSOCIATION CE-S4-12

Abies lasiocarpa/Vassinium scoparium

subalpine fir/grouse huckleberry



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all Districts of the Forest, but is especially common northwest of Conconully in the area termed "the Meadows." Elevations range from 5,500 to over 6,900 feet (average 6,265) and aspects are variable. Most slopes are moderate, ranging from 3% to 65% (average 21%). Slope position is usually mid to upper 1/3 with various microreliefs. Most soils are derived from granitic glacial till, usually with sandy loam to sand textures. Coarse fragments range from 1% to 41% (average 29%) and surface rock ranges from 2% to 15% (average 6%). Pit depths are 18 to 25 inches (average 21). Soils can be summarized as cold, acid, shallow, droughty and poorly developed. The ABLA2/VASC association represents an environment that is cold and relatively dry with frost or snow possible any day of the year.

VEGETATIVE COMPOSITION:

PICO dominates the overstory in most stands with 93% constancy and 34% mean cover. PIEN is the next most common overstory species, with 70% constancy and 15% mean cover. ABLA2 is present in the overstory in less than half of the stands. Sites are generally too harsh for PSME and LAOC. Overstory tree cover averages about 46%. ABLA2 or PIEN dominate the regeneration layer in most stands.

Shrubs other than VASC or VAMY are relatively uncommon. VASC has 96% constancy and 33% cover, while VAMY has 52% constancy and 15% mean cover.

Herbs are normally sparse, but LULA or LUWY are conspicuous in some stands. ARCO or ARLA occur in just over half of the stands sampled.

INDICATORS:

The dominance of VASC with little or no CARU distinguishes this type from all others on the Forest. Increasing LEGL and RHAL indicate a transition to the more moist ABLA2/RHAL association. CARU cover of more than 5% indicates a transition toward the ABLA/VASC/CARU association. High cover of VAMY and/or presence of LEGL suggests sites less severe than normal for the type. Figure 7 portrays the relationship of this type to others on the Forest.

PRODUCTIVITY:

Most stands studied meet the 20 cubic feet per acre/year wood production rate often used as a minimum standard for commercial forest land. This is true for estimates made with either GBA-Site Index or Stand Density Index. However, these estimates do not portray stand diameters. Stand Density Index estimates of quadratic mean diameters for the association range between 2.5 and 11.2 inches; with an average for all twelve plots of only 6.4 inches. Stands may grow at more than 20 cubic feet per year, but growth is distributed on many small stems instead of fewer larger ones. This is typical of stands of PICO, but is particularly common in the ABLA2/VASC association.

Site index tends to decrease with increasing elevation, especially above 6,500 feet. Stand basal areas may remain the same, but trees become progressively shorter in stature. Consequently, productivity decreases even though stand basal areas and quadratic mean diameters remain similar.

SUCCESSIONAL RELATIONSHIPS:

Average stand age is 155 years. The oldest stand is 248 years old (Plot #5166); some of the oldest PICO and PIEN are nearly 300 years old. The youngest stand sampled is 49 years old (Plot #5169). The youngest plot has the greatest amount of PICO and the oldest plot the least. The oldest stand also has the greatest percentage of PIEN and ABLA2. This suggests a trend of eventual replacement of PICO by PIEN and ABLA2. This is the conclusion reached by Daubenmire and Daubenmire (1968) about the successional roles of these species in eastern Washington and northern Idaho. However, this successional sequence is not well defined in all stands. On some plots PIEN is older than PICO (ABLA2 ages were not sampled). Disturbances that remove only a few trees in a stand without killing the whole stand appear to be important influences on stand structures. Small openings in the canopy may help maintain PICO as a stand component for extended periods of time. In any case, the successional sequence is slow and even after more than 300 years stands have not reached climax condition postulated for the association. Typically, disturbances are frequent enough to maintain nearly all areas in a PICO subclimax. Fires, either prior to or following an insect attack, destroy most stands before they are 200 years old. Late opening cones on PICO then open and the newly disturbed area is seeded with PICO ahead of more shade tolerant species. Thus, PICO by repeated disturbances maintains dominance in all but a few stands.

SILVICULTURE:

Frost hazard is extreme from both re-radiation cooling and cold air drainage. PICO is the only species sufficiently well represented in the data to recommend for reforestation, though PIEN may do well on those sites with LEGL, RHAL and VAMY. Species conversion is questionable and, as observed by Pfister and others (1977), is best considered an experiment. PSME, LAOC and PIPO are not adapted to the conditions characteristic of this association.

Most roots are concentrated in the upper foot or less of soil suggesting available nutrients are low, and removal of the upper soil horizons will reduce productivity.

Clearcutting and burning is not an exact substitute for the catastrophic wildfires normal in the ABLA2/VASC association. Wildfire leaves the soil physically undisturbed but, more than that, snags provide both shade from the sun and protection from frost. Removal of the trees removes the protection, thus increasing stress on young trees. Wildfire areas often have excessive regeneration, but harvest areas may have no regeneration at all. Mistletoe is generally light.

Reasonable growth rates on PICO can be maintained by stocking level control. Thin before stands have stagnated to insure good response. In Canada, grass seeding is used to help maintain stocking level control in PICO communities. Successful timber management in the ABLA2/VASC association requires proper silvicultural prescriptions and application.

RANGE MANAGEMENT:

Most natural stands contain little forage for livestock. Standard pasture grasses do very well for reseeding as shown by the many excellent grass stands in old burns. Fertilize to ensure grass establishment.

COMPARISONS:

Associations nearly identical to the ABLA2/VASC association have been reported by many workers in the Pacific Northwest; only the most applicable studies are cited. The association has been reported in Montana by Pfister and others (1977), central Idaho by Steele and others (1981), eastern Washington and northern Idaho by Daubenmire and Daubenmire (1968), eastern Oregon by Hall (1973) and British Columbia by McLean (1970).

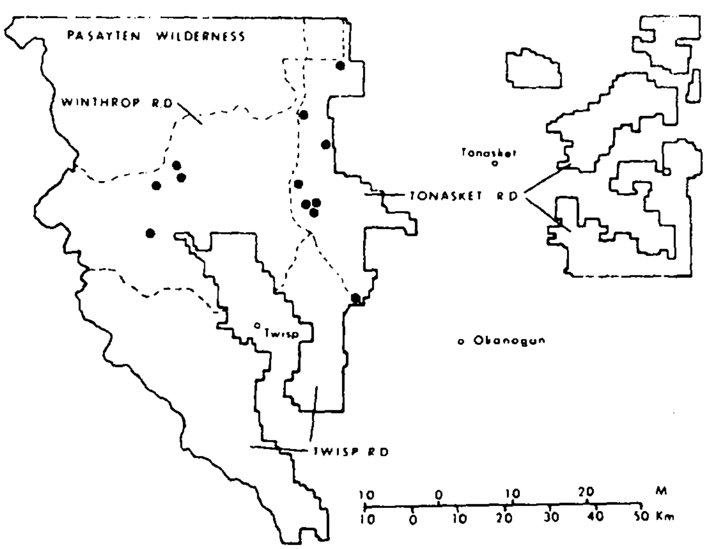
PRODUCTIVITY ESTIMATES

Plots = 12	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	11	1- 54	10	4.7
TBA (sq. ft/acre)	209	122-313	34	15.5
STAND DENSITY INDEX (SDI)	409	275-543	56	25.2
SDI GROWTH EST (cu. ft/ac/yr)	27	13- 58	8	3.8

SPECIES (# plots)			SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
			Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PICO	(12)	57*	31	4	1.9	173	29	13.2	49	13	5.9
PIEN	(3)	63*	36	9	3.4	203	83	29.2	64	34	12.1

* Site index adjusted to a base 100 scale.

ABLA2/RHAL ASSOCIATION CE-S2-11
<u>Abies lasiocarpa/Rhododendron albiflorum</u>
Subalpine fir/Cascade azalea



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all districts of the Forest. Elevations range from 4,570 to 6,310 feet (average 5,742) and aspects are northerly. Most slopes are moderate, ranging from 9% to 52% (average 29%) and slope positions are various, usually with flat to convex microrelief. Soils are derived from various parent materials; most commonly in glacial outwash or till with sandy loam to sand textures. Some surface horizons have silt loam textures because of the presence of volcanic ash. Coarse fragments range from 23% to 43% (average 33% and surface rock ranges from 1% to 10% (average 2%). Pit depths are from 17 to 40 inches (average 29) and rooting depths range from 9 to 32 inches (average 19). Soils are generally cold, moist and acid.

The relatively high elevation north slopes typical of the association are important watershed areas. Snowpacks are high and many stream headwaters are within the ABLA2/RHAL association.

VEGETATIVE COMPOSITION:

ABLA2 and PIEN are present in the overstory of 96% of the samples, with mean cover of 23% and 5%, respectively. PIEN dominates more stands than any other tree. PICO is present in half the stands, with mean cover of 20%. PSME occurs in 33% of the stands sampled. Overstory tree cover averages about 52%. ABLA2 dominates the understory in most stands, and is present in all stands. PIEN regeneration is present in half of the samples and occasionally dominates the reproduction layer.

Shrubs form a dominant and conspicuous part of the understory. Often, the shrub component is multilayered. RHAL and LEGL are the most common tall shrubs, with 79% and 58% constancy, and 15% and 28% mean cover, respectively. VASC and PYSE usually form the low shrub layer with 88% and 54% constancy, with 21% and 2% mean cover. VAME is present in only 25% of the samples, but averages 18% mean cover and forms the intermediate shrub layer.

Many herbs are sometimes present, but only ARCO occurs in half the samples. Mean coverages for any one herb species usually falls between 2% and 5%. Streamside sites at elevations lower than the norm for the ABLA2/RHAL may support a similar community with LEGL as the main shrub with RHAL largely absent.

INDICATORS:

The presence of RHAL or LEGL with more than 5% cover distinguish this type from all others on the Forest, with the exception of ABAM/RHAL which contains ABAM.

High cover of LEGL indicates sites unsuitable for PSME. Increasing VAME is indicative of lower elevations and presumably warmer sites. Decreasing RHAL and shrubs other than VASC, with decreasing herbs, indicate a transition to the drier ABLA2/VASC association. Increasing ABAM indicates a transition to the more maritime ABAM/RHAL association. Increasing PHEM with the general decrease in all other understory species, except VASC, indicate a trend toward the cooler ABLA2/PHEM association. Some very swampy sites will key to ABLA2/RHAL but management implications of PIEN/EQUIS better fit these very wet conditions. These sites are on muck soils with a high cover of mosses and CAREX. RHAL is absent but LEGL is abundant.

PRODUCTIVITY:

SDI estimate of 50 cu. ft/ac/yr is near average for the ABLA2 series. (Timber productivity is somewhat higher in lower elevation stands where RHAL is absent.) PIEN appears to be the most productive species in this type. Herbage production at 79 lbs/acre is well below the 132 lbs/acre average for the ABLA2 series.

SUCCESSIONAL RELATIONSHIPS:

PIEN or ABLA2 dominate most stands, clearly indicating a trend toward an ABLA2 climax. ABLA2 also dominates the regeneration in most stands and is always present. Fires occur infrequently. Often, adjacent drier associations will be burned while the ABLA2/RHAL type is relatively unaffected. Stands where PIEN is older than PICO are not uncommon, suggesting small portions of stands are disturbed, but that entire stands are infrequently destroyed.

SILVICULTURE:

Cold conditions, often in areas of snow accumulation, limits growth rates. PIEN, ABLA2 and PICO are suited to all sites, but PSME is found only on sites at the warmer extreme of the ABLA2/RHAL association. Removal of trees may raise the water table through decreased evapotranspiration, creating springs or boggy areas. PIEN is indicated in areas with high water tables. Clearcuts that have been broadcast burned have less RHAL than adjacent uncut stands. Additional study is needed to determine if the reduction in RHAL is due to damage from logging equipment, broadcast burning or removal of the tree cnaopy. Tall shrubs are conspicuous in old clearcuts, but do not appear to be a serious hinderance to tree regeneration. Regeneration on units that have been clearcut and burned is generally good. Nevertheless, potential for shrub development is high and some scarification may be advisable on sites where preharvest shrub cover exceeds 20%.

RANGE MANAGEMENT:

Normally this association is unsuited for domestic livestock because of the lack of forage, steep slopes and dense shrub cover. Standard pasture grasses and moisture tolerant grasses are suitable for seeding and can provide transitory range. Potential for water developments is high.

COMPARISONS:

Daubenmire and Daubenmire (1968) describe an ABLA2/MEFE association that occasionally contains RHAL. MEFE and RHAL are both relatively tall shrubs with similar growth forms. MEFE is absent from our area, as is XETE, a nearly constant associate in their sites. Even though there are considerable floristic differences in their association from ours, a similar environment is indicated. The same remarks hold true for the ABLA2/MEFE association of Montana of Pfister and others (1977), and for central Idaho of Steele and others (1981).

PRODUCTIVITY ESTIMATES

Plots = 12	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	79	0-387	91	40.8
TBA (sq. ft/acre)	197	139-247	21	9.4
STAND DENSITY INDEX (SDI)	384	256-589	65	29.6
SDI GROWTH EST (cu. ft/ac/yr)	50	19- 84	13	5.9

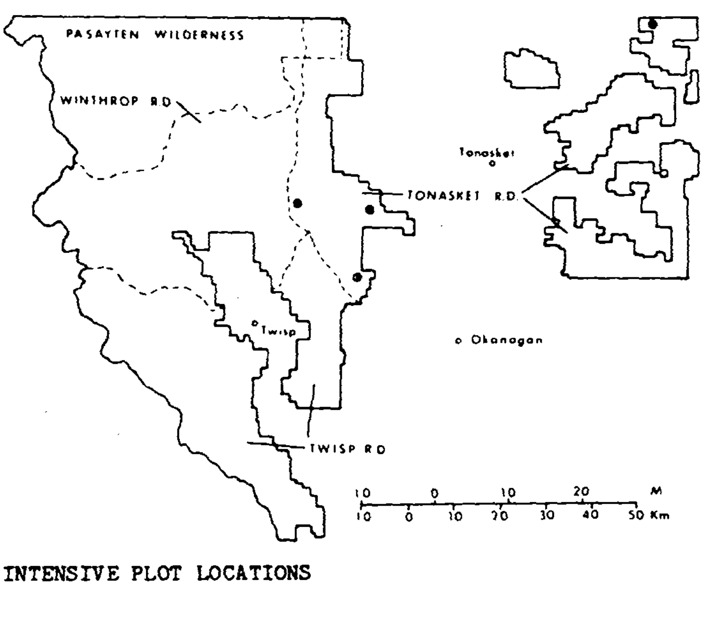
SPECIES (# plots)		SITE INDEX			GBA/10			GBA-SI GROWTH EST.		
		Mean	5%CI	SE	Mean	5%CI	SE	Mean	5%CI	SE
PIEN (10)	79*	51	9	3.9	191	35	15.5	75	25	11.0
ABLA2 (8)		72	11	4.6	154	27	11.3	55	14	6.1
PICO (4)	61*	35	15	4.9	185	42	13.2	56	25	7.9
PSME (3)		67	**	**	167	**	**	57	**	**

* Site index adjusted to a base 100 scale.
** Indicates data insufficient to calculate statistics.

PIEN/EQUIS (OKAN) ASSOCIATION CE-M2-11

Picea engelmannii/Equisetum

Engelmann spruce/horsetail



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all districts of the Forest, but is most extensive in the Pasayten Wilderness. Elevations range from 3,550 to 4,880 feet (average 4,068) and aspects are variable. Slopes are moderate, ranging from 1% to 44% (average 16%). Slope position is usually lower 1/3 to bottoms with flat microrelief. Soils are usually formed in till or alluvium with silty clay loam to sand textures. Coarse fragments range from 30% to 50% (average 40%) and surface rock is either 1% or 2%. Pit depths are from 22 to 30 inches (average 26) and rooting depths range from 6 to 16 inches (average 11). Soils are usually high in organic matter on the surface and are wet due to perched water tables. This association is found on saturated soils with water that moves through the soil and is not stagnant.

VEGETATIVE COMPOSITION:

PIEN dominates the overstory of all stands. Small amounts of LAOC, ABLA2, PICO and PSME are occasionally present and seem restricted to drier microsites. POTR2 occurs in one sample with 15% cover. Overstory tree cover averages 50%. PIEN dominates the regeneration of every stand. PSME and ABLA2 occur in one stand each with low cover.

RILA and COCA are present in all samples and both average 7% cover. LIBOL and ALSI are fairly abundant in most samples. Many other shrubs are sometimes present, usually with low cover.

Equisetum species occur in all stands and average 42% cover. The herb flora is rich and variable with SMST, GATR, MITEL and CAREX usually present. The most frequently encountered Equisetum is E. arvense (EQAR), but E. scirpoides dominated one of the five plots we have. PESA dominated one stand.

INDICATORS:

The dominance of PIEN, both in the overstory and the regeneration layer, with abundant Equisetum distinguishes this association from all others on the Forest. Decreasing PIEN and Equisetum with decreasing soil moisture, organic horizons and increase of other conifers, indicates transition to drier plant associations. Decreasing PIEN and Equisetum with increasing soil moisture and surface water indicates a transition to stream or lake margin vegetation.

PRODUCTIVITY:

Relative timber productivity is higher than the mean for the ABLA2 series. Stands on steeper slopes appear to have higher productivity than those on gentle slopes, probably a result of better soil aeration. The rich herbaceous layer produces high amounts of herbage.

SUCCESSIONAL RELATIONSHIPS:

PIEN dominates the overstory and understory of all stands. ABLA2 is present in a few stands, but is generally restricted to drier microsites, so PIEN is judged to be the climax dominant. No evidence of fire was seen in any of the samples. It appears the fires that do occur generally replace the stands. At higher elevations, the ABLA2/EQUIS association is replaced by the ABLA2/RHAL association on moist to wet sites.

SILVICULTURE:

These stands are relatively high in timber productivity, but the wet soils make management for timber production difficult. PIEN is the only tree recommended. Tree removal may increase the amount of water on the site by reducing evapotranspiration. Saturated soils greatly inhibit tree regeneration, increase risk of windthrow and create extreme problems for road construction and maintenance.

RANGE MANAGEMENT:

Livestock use in the samples is moderate to heavy. Herbage production is good, but palatability is questionable. Livestock appear to frequent these stands to find water and shade. Potential for water developments is excellent. Observed deer use is light, but some shrubs common to this association are highly palatable.

COMPARISONS:

Pfister and others (1977) describe a PICEA/EQAR association in Montana that appears identical to our PIEN/EQUIS association, except their stands contain considerable genetic material from Picea glauca. Steele and others in central Idaho describe a PIEN/EQAR for their area that also appears similar.

PRODUCTIVITY ESTIMATES

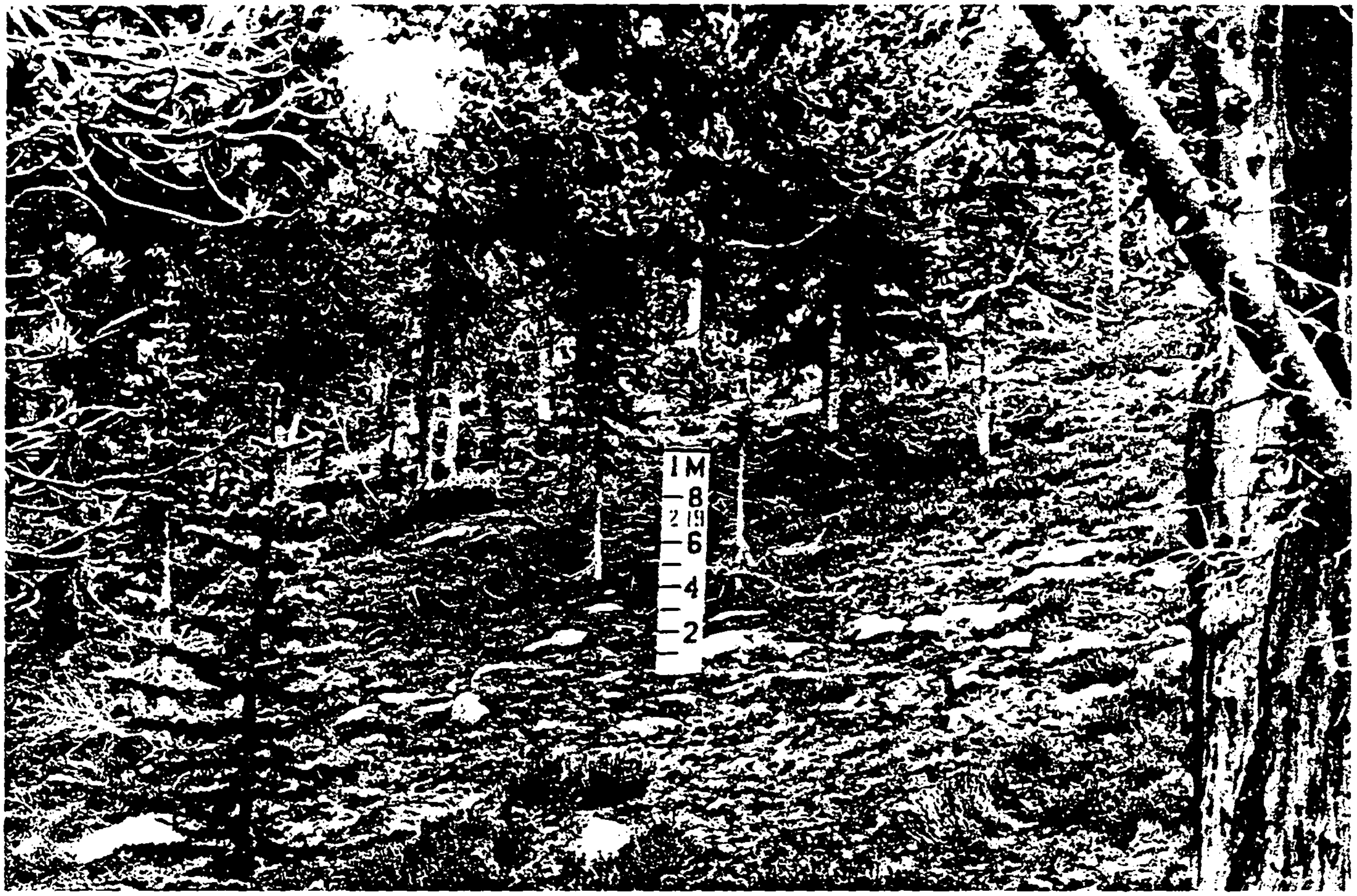
Plots = 4

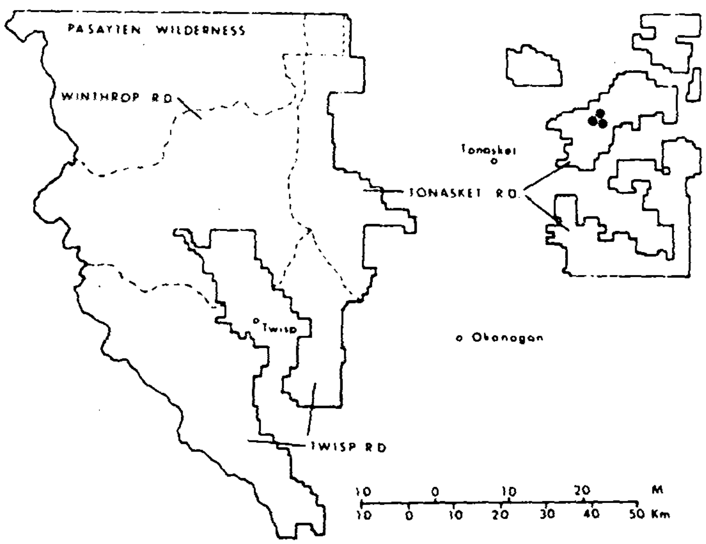
	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	315	0-720	872	202.6
TBA (sq. ft/acre)	218	142-312	121	38.1
STAND DENSITY INDEX (SDI)	312	165-446	227	71.5
SDI GROWTH EST (cu. ft/ac/yr)	69	15-120	78	24.6

SPECIES (# plots)		SITE INDEX Mean	SITE INDEX 5%CI	SITE INDEX SE	GBA/10 Mean	GBA/10 5%CI	GBA/10 SE	GBA-SI GROWTH EST. Mean	GBA-SI GROWTH EST. 5%CI	GBA-SI GROWTH EST. SE
PIEN (4)	100*	64	**	**	244	**	**	122	**	**

* Site index adjusted to a base 100 scale.
** Indicates data insufficient to calculate statistics.

ABLA2/PHEM ASSOCIATION CE-S6-11
Abies lasiocarpa/Phyllodoce empetriformis
subalpine fir/red mountainheath





INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association occurs on all districts of the Forest, but was sampled only on Tonasket. Data are from just three samples. Elevations range from 6,700 to 7,030 feet (average 6,877) and aspects are northerly. Slopes range from 10% to 35% (average 23%). Slope position is upper 1/3 to ridgetop on convex microrelief. Surface rock ranges from 7% to 35% (average 19%). No soil profile data are available. This association indicates cold and wet growing conditions. Snow is present well into summer and frost is possible throughout the year.

VEGETATIVE COMPOSITION:

PIEN, PIAL and ABLA2 occur in the overstory of all stands. PICO dominated one stand. Mean overstory tree cover averages only 35% due to the open, stunted condition typical of the association. ABLA2 was slightly more abundant than PIEN and

and PIAL in the regeneration layer. These three species occurred in the understory of all samples.

PHEM and VASC were present in all stands with individual coverages usually over 10%. LEGL and/or RHAL occurred in two of the three plots. Lichens are the only non-woody species consistently present.

INDICATORS:

The co-dominance of PHEM and VASC without any herbaceous vascular plants distinguishes this association from any other on the Forest. Decreasing PHEM and PIAL with increasing RHAL and other shrubs indicates a transition to the warmer ABLA2/RHAL association. Decreasing PHEM and PIAL with increasing shrub and herb cover indicates a transition to the warmer and drier ABLA2/VASC association. Decreasing ABLA2, PIEN and PIAL with increasing LALY indicates a transition to the LALY association.

PRODUCTIVITY:

SDI timber productivity estimates for our plots do not exceed 9 cu. ft/ac/yr. Trees have very poor form. Herbaceous production is very low. Harsh environmental conditions limit plant growth.

SUCCESSIONAL RELATIONSHIPS:

ABLA2, PIAL, PIEN or PICO may dominate stands in this association. This type falls within the ABLA2 series, but complete exclusion of other species by ABLA2 is doubtful because stands do not normally close over. Few trees can tolerate the harsh site conditions. Plant succession proceeds slowly and reforestation after disturbance is inconsistent. Size and durations of snow pack is a major influence on tree establishment.

SILVICULTURE:

Productivity of trees is very low and regeneration success impossible to assure.

RANGE MANAGEMENT:

Little use by livestock or big game animals is evident on these sites. Herbage production is minimal and little forage or browse is normally available.

COMPARISONS:

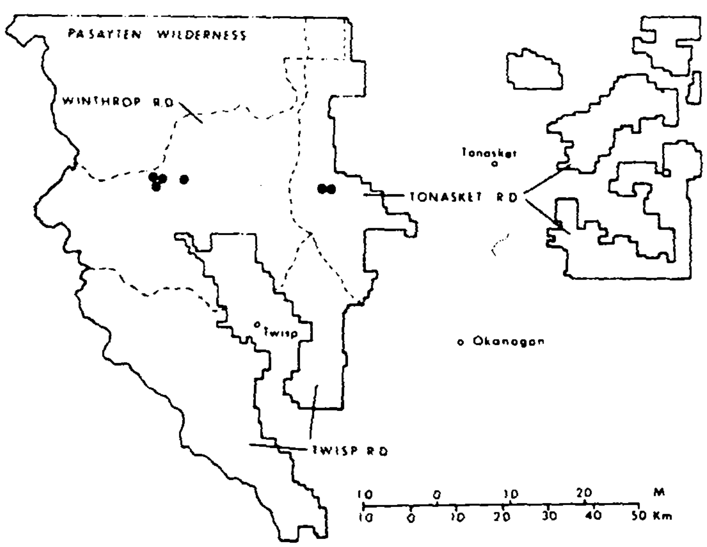
McLean (1970) describes a PHEM phase of his ABLA2/VASC association in southern British Columbia adjacent to our area that appears the same as our ABLA2/PHEM association.

PRODUCTIVITY ESTIMATES

Plots = 3	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	7	1- 20	**	**
TBA (sq. ft/acre)	114	84-174	**	**
STAND DENSITY INDEX (SDI)	230	175-340	**	**
SDI GROWTH EST (cu. ft/ac/yr)	6	5- 9	**	**

** Indicates data insufficient to calculate statistics.

PIAL/CARU ASSOCIATION CA-G1-12
Pinus albicaulis/Calamagrostis rubescens
Whitebark pine/pinegrass



INTENSIVE PLOT LOCATIONS

DISTRIBUTION AND ENVIRONMENT:

This association is found on all districts, but only west of the Okanogan River. Elevations range from 5,810 to 7,340 feet (average 6,625) and aspects are usually southerly. Most slopes are steep, ranging from 30% to 55% (average 42%). Slope position is ridgetop to upper 1/3, usually with flat to concave microrelief. Soils are normally derived from granitics. The single soil profile available has a pit and rooting depth of 12 inches with 49% coarse fragments. Surface rock ranges from 5% to 35% (average 18%).

This association indicates cold, dry growing conditions at extreme elevations. Stands are windswept and many trees are deformed. Sites are extreme and the combination of cold, wind, drought and snow removal by wind creates conditions too severe to form a closed forest.

VEGETATIVE COMPOSITION:

Species composition and sites are sufficiently diverse that several associations could be described in our area. We choose to group sites dominated by PIAL as one association because there presently seems to be little management need to subdivide this upper timberline plant association.

PIAL is the most common tree, but ABLA2, PIEN, PSME and PICO may be present, depending on local conditions and elevations. Mean overstory tree cover is 27%. Shrubs have low coverages and only PAMY and VASC are present in most stands. CARU is the most abundant and consistent herbaceous species. Other herbs are highly variable in cover and constancy.

INDICATORS:

PIAL on dry, windswept southerly to westerly slopes near timberline distinguishes this association from all others on the Forest. Decreasing PIAL and CARU with increasing LALY indicates a transition to the colder LALY association. Decreasing CARU and herbs with an increase in PHEM indicates a transition to the ABLA2/PHEM association.

PRODUCTIVITY:

SDI timber productivity estimate is very low. Many trees are deformed from frost and high winds. Herbaceous production is the highest of all the upper timberline associations and just below average for the ABLA2 series.

SUCCESSIONAL RELATIONSHIPS:

PIAL dominates most stands and is the most common overstory and understory tree. Usually it has a multi-stemmed growth form. Other tree species are usually found in the shelter of established PIAL trees, where effects of wind and strong insolation rates are less. Snow accumulations are greater and melting is delayed on the lee side of existing PIAL trees, creating more moist soils for seedling establishment and survival. PIAL thus provides shelter for more shade tolerant but less hardy species such as ABLA2 and PSME.

Most shrubs are in the shelter of large rocks or trees. Forbs such as LUNA2 and LULA increase with overgrazing. Sites are slow to recover following overgrazing because of frost heaving, winter desication and thin, droughty soils.

SILVICULTURE:

Harsh environmental conditions make reforestation extremely difficult. Hazards include frost, winter dessication, ice damage, drought and high temperatures at the soil-air interface. No techniques are known to assure reforestation.

RANGE MANAGEMENT:

This association is useful for livestock because of its relatively high herbage production. Moderate overgrazing often leads to an increase in LULA and LUNA2 on sedimentary soils. Severe overgrazing creates large areas of bare soil which are highly erosive, both by wind and by water. These bare soil areas are slow to revegetate.

Seeding with standard pasture grasses gives inconsistent results. Fertilization may be required to aid in establishment.

COMPARISONS:

Pfister and others (1977), and Steele and others (1981) report PIAL associations from Montana and central Idaho, respectively. They say a variety of associations are present, but choose to describe areas dominated by PIAl in a general way. It appears that at least some of their sites are comparable with our PIAL/CARU association.

PRODUCTIVITY ESTIMATES

Plots = 6	Mean	Range	5%CI	Standard Error (SE) of the Mean
HERBAGE (lbs/acre)	112	53-165	50	19.4
TBA (sq. ft/acre)	59	24-143	45	17.4
STAND DENSITY INDEX (SDI)	96	47-143	34	13.1
SDI GROWTH EST (cu. ft/ac/yr)	3	1- 7	2	1.0

SPECIES (# plots)	SITE INDEX Mean	5%CI	SE	GBA/10 Mean	5%CI	SE	GBA-SI GROWTH EST. Mean	5%CI	SE
PSME (1)	52	**	**	160	**	**	42	**	**

** Indicates data insufficient to calculate statistics.

LALY (OKAN) ASSOCIATION CA-C1
Larix lyalli
Subalpine larch

DISTRIBUTION AND ENVIRONMENT:

This association is found on all three districts, but only west of the Okanogan River. Elevations range from 6,470 to 6,900 feet (average 6,730) and aspects range from east to west. Slopes are usually moderate, ranging from 23% to 43% (average 26%). Slope position is usually middle to upper 1/3 with convex microrelief. Soils are normally formed in glacial till and appear to be effectively shallow and high in coarse fragments. No other soil data is available because no intensive samples were taken.

This association occurs on cold, snowy sites in many timberline areas west of the Okanogan River in our area. It often forms a "cap" on peaks in the 7,000 foot range. This association is usually most extensive on the northerly sides of these peaks, while the PIAL/CARU association is on southerly aspects.

VEGETATIVE COMPOSITION:

LALY dominates the overstory of all samples. ABLA2 and PIEN are sometimes present in the overstory. Mean overstory tree cover is about 22%. ABLA2 dominates the understory of most stands, but these trees are often stunted, deformed and shrub-like (krummholz) in form. The LALY regeneration size trees present are erect and tree-like in form. PIAL and PIEN may be present in the regeneration layer.

Shrub and herb cover is variable, but VASC, PHEM and/or CASSI are present in most stands and any one of these may be abundant. LUHI is the most common and abundant herbaceous species. It occurs in most stands and often has higher cover than any other understory species. CAREX, ARNIC and ANTEN are also usually present.

INDICATORS:

The presence of LALY in sufficient quantity to indicate more than accidental occurrence distinguishes this type from all others on the Forest. Decreasing LALY, CASSI and all herbs with increasing evergreen conifers indicates a transition to the ABLA2/PHEM association. Decreasing LALY, CASSI, PHEM, VASC, LUHI and CAREX with increasing PIAL and other evergreen conifers with increasing PAMY, CARU and ACMI indicates a transition to the PIAL/CARU association.

PRODUCTIVITY:

No intensive sample data are available for this association; however, tree productivity is judged to be low. Herbaceous production appears to be low also. The low productivities appear to be a result of an extremely harsh environment and poor soils.

SUCCESSIONAL RELATIONSHIPS:

LALY is capable of growing on sites that are too severe for other conifers (Arno and Habeck, 1972). Stands do not close over and the dominance of LALY is based on its superior hardiness, instead of competitive ability. LALY may serve as a nurse tree for other species. Shrubs and herbs are variable because of the wide range of site characteristics. Arno (1970) and Arno and Habeck (1972) discuss the ecology and successional relationships in greater detail.

SILVICULTURE:

Timber productivity appears to be very low. Cold temperatures, high snow pack and poor soils are major limitations. Watershed and recreational values far exceed any use for timber. Regeneration may require hundreds of years based on limited data.

RANGE MANAGEMENT:

Little use by livestock or big game animals is currently evident on these sites. Some areas show evidence of past abusive grazing and are very slow to recover.

COMPARISONS:

Arno (1970) and Arno and Habeck (1972) describe in detail the ecology and range of LALY, and some of their data is from our area. Pfister and others (1977) also describe LALY associations which appear comparable to ours.

OTHER VEGETATIVE TYPES

Not all types of forested vegetation presented on the Okanogan National Forest are well represented; consequently our data is limited. Some of these communities are much more common outside of the Forest boundaries.

Near the Cascade crest the maritime influence of the westerly winds become more important and the forest contains abundant amounts of ABAM and TSME. Two associations are recognized within an ABAM series on the Okanogan National Forest. The ABAM series is much better developed on lands administered by the Wenatchee National Forest and associations typified by the prescence of ABAM will be described in more detail in later work.

ABAM/RHAL (OKAN) CF-S5-53
Abies amabilis/Rhododendron albiflorum
Pacific silver fir/Cascade azalea

The ABAM/RHAL association is typified by the presence of ABAM and TSME in the tree stratum over a tall shrubby undergrowth normally dominated by RHAL. This association can be considered to be a maritime counterpart to the ABLA2/RHAL type. It is found most commonly on northerly slopes.

ABAM/PAMY CF-S2-58
Abies amabilis/Pachistima myrsinites
Pacific silver fir/pachistima

The ABAM/PAMY association is poorly defined floristically and environmentally. If more data were available it would probably be subdivided. PAMY is constant but VAME has higher cover and is also constant. PAMY was selected as the character species of the type because of the similarity of the shrub understory to the ABLA2/PAMY association. ABAM/PAMY can also be characterized as a maritime counterpart to the more clearly defined ABLA2/PAMY asociation.

Stands dominated by THPL occur in the same general area as the ABAM types. Elevations are lower than in the ABAM sites. Shrubs and herbs resemble the ABLA2/PAMY type but the undergrowth is very depauperate because of dense shade. THPL is relatively uncommon over most the the Okanogan National Forest, so when it appears in abundance, it is distinctive. The sites appear to be highly productive for timber based on limited sampling.

POTR is found on all districts of the Forest. It is rarely a major landscape component, normally occurring in small clumps of a few acres or less in size; or as scattered trees in conifer dominated stands. The majority of areas with POTR have enough conifer regeneration to indicate eventual conifer dominance. These areas are treated as conifer forest. However, some sites contain little or no conifers and evidence of eventual conifer dominance is lacking. These appear to be successionally stable or climax POTR stands. We have classified these areas into two main types:

POTR/SYAL (OKAN) HQ-S2-11
Populus tremuloides/Symphoricarpos albus
Quaking aspen/common snowberry

This type adjoins marshes or wet meadows or are in drainage depressions. These sites are typified by high cover of SYAL with a variety of moist site herbs. Many of these areas area heavily grazed. The POTR/SYAL association often adjoins the PSME/SYAL association but is found on wetter sites.

POTR/CARU (OKAN) HQ-G1-11
Populus tremuloides/Calamagrostis rubescens
Quaking aspen/pinegrass

The POTR/CARU type is normally found in midslope positions with the ground vegetation dominated by CARU. Shrubs are absent or inconspicious. Some sites are above 6000 feet elevation and the trees are usually smaller in size than those with SYAL. The POTR/CARU association sometimes adjoins the PSME/CARU or PSME/VACCI associations but is on deep, black, fine-textured soils.

Most forested riparian areas on the the Okanogan National forest fall within the PIEN/EQUIS, POTR/SYAL, or ABLA2/RHAL associations. A complex forested community along flood-plains of major streams at elevations below that occupied by the above associations has been observed. It is found on flat, low-lying river terraces subject to periodic flooding. Small stream channels are present. Typical tree species include POTR2, PIEN, and PSME. Shrubs dominate the undergrowth common species include SYAL, COST, SALIX, AMAL, and SPBEL.

Non-forest communities on the Forest are varied and complex. Alpine and subalpine meadows are especially variable. Non-forest types will be described in later studies.

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APPENDIX A

LIST OF ABBREVIATIONS

SCIENTIFIC AND COMMON NAMES OF

TREES, SHRUBS, SUBSHRUBS, AND HERBS

TREES

CODES	SCIENTIFIC NAME	COMMON NAME
ABAM	*Abies amabilis*	Pacific silver fir
ABGR	*Abies grandis*	grand fir
ABLA2	*Abies lasiocarpa*	subalpine fir
LALY	*Larix lyalli*	subalpine larch
LAOC	*Larix occidentalis*	western larch
PIEN	*Picea engelmannii*	Engelmann spruce
PIGL	*Picea glauca*	white spruce
PIAL	*Pinus albicaulis*	whitebark pine
PICO	*Pinus contorta*	lodgepole pine
PIPO	*Pinus ponderosa*	ponderosa pine
POTR	*Populus tremuloides*	quaking aspen
POTR2	*Populus trichocarpa*	black cottonwood
PSME	*Pseudotsuga menziesii*	Douglas-fir
THPL	*Thuja plicata*	western red cedar
TSME	*Tsuga mertensiana*	mountain hemlock

SHRUBS AND SUBSHRUBS

CODES	SCIENTIFIC NAME	COMMON NAME
ACGLD	*Acer glabrum* var. *douglasii*	Douglas maple
ALSI	*Alnus sinuata*	Sitka alder
AMAL	*Amelanchier alnifolia*	serviceberry
ARNE	*Arctostaphylos nevadensis*	pinemat manzanita
ARUV	*Arctostaphylos uva-ursi*	bearberry
BEAQ	*Berberis aquifolium*	Oregon grape
CASSI	*Cassiope* species	moss-heather
CEVE	*Ceanothus velutinus*	snowbrush ceanothus
CHUMO	*Chimaphila umbellata* var. *occidentalis*	western princess pine
COCA	*Cornus canadensis*	bunchberry dogwood
COST	*Cornus stolonifera*	red-osier dogwood
HODI	*Holodiscus discolor*	ocean-spray
LEGL	*Ledum glandulosum*	Labrador tea
LIBOL	*Linnaea borealis* var. *longiflora*	twinflower
LOIN	*Lonicera involucrata*	bearberry honeysuckle
LOUT	*Lonicera utahensis*	Utah honeysuckle
MEFE	*Menziesia ferruginea*	rusty menziesia
PAMY	*Pachistima myrsinities*	pachistima
PEFR3	*Penstemon fruiticosus*	shrubby penstemon
PHEM	*Phyllodoce empetriformis*	red mountain heath
PHMA	*Physocarpus malvaceus*	ninebark
PUTR	*Purshia tridentata*	bitterbrush
PYAS	*Pyrola asarifolia*	alpine pyrola
PYCH	*Pyrola chlorantha*	green pyrola
PYSE	*Pyrola secunda*	sidebells pyrola
RHAL	*Rhododendron albiflorum*	Cascade azalea
RICE	*Ribes cereum*	wax currant
RILA	*Ribes lacustre*	prickly currant
RIVI	*Ribes viscosissimum*	sticky currant
ROGY	*Rosa gymnocarpa*	baldhip rose

SHRUBS AND SUBSHRUBS (continued)

CODES	SCIENTIFIC NAME	COMMON NAME
ROSA	Rosa spp.	rose species
ROWO	Rosa woodsii	woods rose
RUPA	Rubus parviflorus	western thimbleberry
SALIX	Salix spp.	willow species
SASC	Salix scouleriana	Scouler willow
SHCA	Shepherdia canadensis	russet buffaloberry
SOSC2	Sorbus scopulina	mountain ash
SPBEL	Spirea betulifolia var. lucida	shiny leaf spirea
SYAL	Symphoricarpos albus	common snowberry
SYOR	Symphoricarpos oreophilus	mountain snowberry
VACA	Vaccinium caespitosum	dwarf huckleberry
VACCI	Vaccinium spp.	huckleberry species
VAME	Vaccinium membranaceum	big huckleberry
VAMY	Vaccinium myrtillus	low huckleberry
VASC	Vaccinium scoparium	grouse huckleberry
XETE	Xerophyllum tenax	beargrass

HERBS

CODES	SCIENTIFIC NAME	COMMON NAME
ACMI	*Achillea millefolium*	yarrow
ACRU	*Actaea rubra*	baneberry
ADBI	*Adenocaulon bicolor*	pathfinder
AGSP	*Agropyron spicatum*	bluebunch wheatgrass
AGIN	*Agropyron spicatum* var. *inerme*	beardless bluebunch wheatgrass
ANPI	*Anemone piperi*	Piper anemone
ANTEN	*Antennaria* species	pussytoes species
ANMI	*Antennaria microphylla*	rose pussytoes
ANRA	*Antennaria racemosa*	raceme pussytoes
ANUM	*Antennaria umbrinella*	umber pussytoes
APAN	*Apocynum androsaemifolium*	spreading dogbane
AQUIL	*Aquilegia* species	columbine species
ARNIC	*Arnica* species	arnica species
ARCO	*Arnica cordifolia*	heartleaf arnica
ARLA	*Arnica latifolia*	broadleaf arnica
ASMI	*Astragalus miser*	starved milkvetch
ASCO	*Aster conspicuus*	showy aster
ASTER	*Aster* species	aster species
BASA	*Balsamorhiza sagittata*	arrowleaf balsamroot
BROMU	*Bromus* species	bromegrass species
BRTE	*Bromus tectorum*	cheatgrass
BRSU	*Bromus suksdorfii*	Suksdorf brome
BRVU	*Bromus vulgaris*	Columbia brome
CACO	*Carex concinnoides*	northwestern sedge
CAGE	*Carex geyeri*	elk sedge
CAREX	*Carex* species	sedge species
CARO	*Carex rossii*	Ross sedge
CARU	*Calamagrostis rubescens*	pinegrass
CASTI	*Castilleja* species	paintbrush species
CEDI	*Centarea diffusa*	diffuse knapweed

HERBS (continued)

CODE	SCIENTIFIC NAME	COMMON NAME
CLCO	Clematis columbiana	rock clematis
CLUN	Clintonia uniflora	queencup beadlily
COGR	Collinsia grandiflora	bluetips collinsia
COPA	Collinsia parviflora	littleflower collinsia
CRAT	Crepis atrabarba	slender hawksbeard
DENU3	Delphinium nuttallianum	larkspur
DITR	Disporum trachycarpum	fairybells
ELGL	Elymus glaucus	blue wildrye
EQUIS	Equisetum species	horsetail species
EQAR	Equisetum arvense	common horsetail
EQSC	Equisetum scirpoides	sedgelike horsetail
FEID	Festuca idahoensis	Idaho fescue
FEOC	Festuca occidentalis	western fescue
FRAGA	Fragaria spp.	strawberry species
GATR	Galium triflorum	sweetscented bedstraw
GOOB	Goodyera oblongifolia	western rattlesnake plantain
GYDR	Gymnocarpium dryopteris	oak fern
HECY	Heuchera cylindrica	roundleaf alumroot
HIERA	Hieracium species	hawkweed species
HIAL	Hieracium albiflorum	white hawkweed
HICY	Hieracium cynoglossoides	houndstongue hawkweed
KOCR	Koeleria cristata	prairie Junegrass
LICHE	Lichen species	lichen species
LIRU	Lithospermum ruderale	wayside gromwell
LODI	Lomatium dissectum	lomatium
LUHI	Luzula hitchcockii	smooth woodrush
LUNA2	Luina nardosima	luina
LUPIN	Lupinus species	lupine species
LULA	Lupinus latifolius	broadleaf lupine
LUSE	Lupinus sericeus	silky lupine
LUWY	Lupinus wyethii	Wyeth lupine

HERBS (continued)

CODE	SCIENTIFIC NAME	COMMON NAME
MITEL	*Mitella* species	miterwort species
OSCH	*Osmorhiza chilensis*	sweetroot
PEBR	*Pedicularis bracteosa*	bracted pedicularis
PEPR2	*Penstemon pruinosus*	prickleaf penstemon
PERA	*Pedicularis racemosa*	sickletop pedicularis
PESA	*Petasites sagittatus*	arrowleaf butterbur
POA	*Poa* species	bluegrass species
PONE	*Poa nervosa*	Wheeler bluegrass
SETR	*Senecio triangularis*	arrowleaf groundsel
SMRA	*Smilacina racemosa*	feather solomonplume
SMST	*Smilacina stellata*	starry solomonplume
STAM	*Streptopus amplexifolius*	claspleaf twisted stalk
THOC	*Thalictrum occidentale*	western meadowrue
VASI	*Valeriana sitchensis*	Sitka valerian
VIAD	*Viola adunca*	Hook violet
VIGL	*Viola glabrella*	pioneer violet

APPENDIX B

CODES USED IN PRODUCTIVITY
DATA SUMMARIES AND TABLES

LIST OF PRODUCTIVITY CODES

SPECIES		CODE
<u>Abies amabilis</u>	ABAM	PS
<u>Abies lasiocarpa</u>	ABLA2	SA
<u>Larix occidentalis</u>	LAOC	WL
<u>Picea engelmannii</u>	PIEN	ES
<u>Pinus contorta</u>	PICO	LP
<u>Pinus ponderosa</u>	PIPO	PP
<u>Pseudotsuga menziesii</u>	PSME	DF

The following attributes are given for each species.

ATTRIBUTE	CODE
Number of sample trees	N
Growth Basal Area	GBA
Site Index	SI
Average age of site index trees	AGE
Cubic feet per year production as determined with GBA and SI.	CU

Each plot contains data on the following attributes which are not species specific.

ATTRIBUTE	CODE
Total basal area	TBA
Stand Density Index	SDI
Cubic feet per year production as determined by SDI.	SDICU
Herbage production in pounds per acre.	HERBGE

Hence a plot with productivity data taken on PIPO and PSME would include the following productivity related items:

PLOT AS A WHOLE	FOR PIPO	FOR PSME
HERBGE	PPN	DFN
TBA	PPAGE	DFAGE
SDI	PPGBA	DFGBA
SDICU	PPCU	DFCU
	PPSI	DFSI

APPENDIX C

NAMES, ECOCLASS CODES, AND INTENSIVE

PLOT NUMBERS OF EACH ASSOCIATION

NAMES, ECOCLASS CODES, AND INTENSIVE PLOT
NUMBERS FOR EACH ASSOCIATION

PIPO-PSME/AGIN ASSOCIATION CD-G3-11
PINUS PONDEROSA-PSEUDOTSUGA MENZIESII/AGROPYRON SPICATUM var. INERME
Ponderosa pine-Douglasfir/beardless bluebunch wheatgrass
(5001 5002 5003 5005 5011 5013 5014 5015 5018 5019 5020 5021 5025 5026 5068)

PSME/ARUV-PUTR ASSOCIATION CD-S6-31
PSEUDOTSUGA MENZIESII/ARCTOSTAPHYLOS UVA-URSI-PURSHIA TRIDENTATA
Douglas-fir/bearberry-bitterbrush
(5004 5006 5012 5044 5045 5056 5058 5060 5205)

PSME/ARUV(OKAN) ASSOCIATION CD-G1-23
PSEUDOTSUGA MENZIESII/ARCTOSTAPHYLOS UVA-URSI
Douglas-fir/bearberry
(5047 5048 5050 5052 5055 5061 5202 5204**5074 5075 W/ARNE)

PSME/CARU(OKAN)ASSOCIATION CD-G1-31
PSEUDOTSUGA MENZIESII/CALAMAGROSTIS RUBESCENS
Douglas-fir/pinegrass
(5016 5024 5031 5032 5033 5034 5036 5037 5038 5040 5041 5042 5049 5053 5059 5069 5070 5071 5076 5077 5081 5082 5083 5085 5086 5087 5088 5089 5097 5100 5103 5115 5116 5117 5120 5125 5130 5132 5193)

PSME/VACCI ASSOCIATION CD-S8-11
PSEUDOTSUGA MENZIESII/VACCINIUM SPP.
Douglas-fir/huckleberry
(5022 5023 5027 5028 5039 5043 5046 5054 5057 5121 5122 5128 5143 5144)

PSME/SYAL(OKAN) ASSOCIATION CD-S6-33
PSEUDOTSUGA MENZIESII/SYMPHORICARPOS ALBUS
Douglas-fir/ common snowberry
(5008 5009 5029 5067 5107)

PSME/SYOR(OKAN) ASSOCIATION CD-S6-32
PSEUDOTSUGA MENZIESII/SYMPHORICARPOS OREOPHILUS
Douglas-fir/mountain snowberry
(5010 5017 5030 5035 5062 5113 5185)

PSME/PAMY(OKAN) ASSOCIATION CD-S4-11
PSEUDOTSUGA MENZIESII/PACHISTIMA MYRSINITES
Douglas-fir/pachistima
(5106 5118 5119 5155 5156 5161)

PSME/PHMA(OKAN) ASSOCIATION CD-S7-15
PSEUDOTSUGA MENZIESII/PHYSOCARPUS MALVACEUS
Douglas-fir/ninebark
(5152 5154 5199 5201)

ABLA2/VACCI ASSOCIATION CE-S3-12
ABIES LASIOCARPA/VACCINIUM SPP.
Subalpine fir/huckleberries
(5051 5084 5096 5123 5124 5126 5127 5129 5140 5141 5142 5148 5151 5163 5191 5192 5194 5195 5198 5221 5222 5223)

ABLA2/LIBOL(OKAN) ASSOCIATION CE-F2-11
ABIES LASIOCARPA/LINNAEA BOREALIS var. LONGIFLORA
Subalpine fir/twinflower
(5078 5090 5091 5093 5095 5131 5133 5139 5145 5147 5149 5150 5153 5162 5171 5184 5189 5196 5200 5207 5208 5164)

ABLA2/PAMY(OKAN) ASSOCIATION CE-S1-11
ABIES LASIOCARPA/PACHISTIMA MYRSINITES
Subalpine fir/pachistima
(5104 5108 5157 5158 5159 5160 5183)

ABLA2/VASC/CARU(OKAN) ASSOCIATION CE-S4-13
ABIES LASIOCARPA/VACCINIUM SCOPARIUM/CALAMAGROSTIS RUBESCENS
Subalpine fir/grouse huckleberry/pinegrass
(5064 5066 5072 5073 5173)

ABLA2/CARU(OKAN) ASSOCIATION CE-G3-11
ABIES LASIOCARPA/CALAMAGROSTIS RUBESCENS
Subalpine fir/pinegrass
(5063 5079 5080 5099 5114 5186 5190)

ABLA2/VASC(OKAN) ASSOCIATION CE-S4-12
ABIES LASIOCARPA/VACCINIUM SCOPARIUM
Subalpine fir/grouse huckleberry
(5137 5138 5165 5166 5167 5169 5172 5174 5029 5210 5212 5217)

ABLA2/RHAL ASSOCIATION CE-S2-11
ABIES LASIOCARPA/RHODODENDRON ALBIFLORUM
Subalpine fir/Cascade azalea
(5065 5092 5102 5110 5134 5135 5136 5168 5170 5175 5176 5187)

PIEN/EQUIS(OKAN) ASSOCIATION CE-M2-11
PICEA ENGELMANNII/EQUISETUM SPP.
Engelmann spruce/horsetail
(5094 5101 5197 5206)

ABLA2/PHEM ASSOCIATION CE-S6-11
ABIES LASIOCARPA/PHYLLODOCE EMPETRIFORMIS
Subalpine fir/red mountainheath
(5218 5219 5220)

PIAL/CARU ASSOCIATION CA-G1-12
PINUS ALBICAULIS/CALAMAGROSTIS RUBESCENS
Whitebark pine/pinegrass
(5188 5211 5213 5214 5215 5216)

ABAM/PAMY ASSOCIATION CF-S5-58
ABIES AMABILIS/PACHISTIMA MYRSINITES
Pacific silver fir/pachistima
(5179 5181)

ABAM/RHAL(OKAN) ASSOCIATION CF-S5-53
ABIES AMABILIS/RHODODENDRON ALBIFLORUM
Pacific silver fir/Cascade azalea
(5177 5178 5180)

POTR/CARU-OKAN ASSOCIATION HQ-G1-11
POPULUS TREMULOIDES/CALAMAGROSTIS RUBESCENS
Quaking aspen/pinegrass
(5098 5111)

POTR/SYAL-OKAN ASSOCIATION HQ-S2-11
POPULUS TREMULOIDES/SYMPHORICARPOS ALBUS
Quaking aspen/common snowberry
(5146)

LALY(OKAN) ASSOCIATIONS CA-C1
LARIX LYALLI
Subalpine larch (None in Okanogan N.F. intensive data.)

THE FOLLOWING PLOTS ARE UNCLASSIFIED FOR ONE REASON OR ANOTHER (5105 5182 have THPL 5109 is subirrigated 5112 has no trees 5203 burned)

(*) Association names that duplicate names of other authors are distinguished by the addition of the geographic identifier OKAN as part of the code. Association names not used previously do not have the identifier as part of the name.

APPENDIX D

MEAN COVER AND CONSTANCY OF IMPORTANT SPECIES BY PLANT ASSOCIATION

MEAN COVER AND CONSTANCY BY ASSOCIATION

	PIPO-PSME/AGIN		PSME/ARUV-PUTR		PSME/ARUV		PSME/CARU		PSME/VACCI		PSME/SYAL	
	(26 PLOTS)		(20 PLOTS)		(30 PLOTS)		(74 PLOTS)		(38 PLOTS)		(10 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
ABLA2O	--	--	--	--	--	--	2	3	--	--	--	--
LAOC O	--	--	13	10	14	37	17	50	19	92	40	10
PIAL O	--	--	--	--	--	--	--	--	--	--	--	--
PICO O	--	--	10	25	9	67	14	24	14	84	10	10
PIPO O	29	100	23	100	12	60	12	47	6	26	41	80
PIEN O	--	--	--	--	--	--	1	1	--	--	--	--
POTR O	--	--	--	--	--	--	10	1	2	3	1	20
PSME O	11	77	19	85	28	100	37	96	24	97	24	90
ABLA2U	--	--	--	--	--	--	1	7	--	--	--	--
LAOC U	--	--	--	--	2	17	2	7	4	42	--	--
PIAL U	--	--	--	--	--	--	--	--	--	--	--	--
PICO U	--	--	5	15	5	50	5	8	3	50	--	--
PIPO U	3	58	2	35	3	17	2	15	1	18	1	40
PIEN U	--	--	--	--	--	--	1	3	--	--	--	--
PSME U	2	54	5	90	7	100	7	93	10	97	5	70
ACGLD	--	--	--	--	--	--	2	3	--	--	2	30
ALSI	--	--	--	--	--	--	--	--	3	16	--	--
AMAL	3	50	3	35	1	33	2	26	1	45	2	60
ARUV	1	4	13	100	15	100	3	34	10	92	--	--
BEAQ	1	4	--	--	--	--	2	5	--	--	3	50
CEVE	3	23	5	65	4	37	2	7	--	--	--	--
CHUMO	--	--	--	--	1	3	1	7	2	8	--	--
COCA	--	--	--	--	--	--	--	--	5	3	--	--
HODI	--	--	--	--	--	--	--	--	--	--	2	30
LEGL	--	--	--	--	--	--	--	--	--	--	--	--
LIBOL	--	--	--	--	2	3	1	3	10	39	--	--
LOUT	--	--	--	--	--	--	--	--	1	3	--	--
PAMY	4	12	2	70	2	67	3	66	4	84	4	40
PHEM	--	--	--	--	--	--	--	--	--	--	--	--
PHMA	--	--	--	--	--	--	--	--	--	--	--	--
PUTR	11	81	6	100	--	--	3	3	--	--	--	--
PYSE	--	--	--	--	1	3	1	3	1	11	--	--
RHAL	--	--	--	--	--	--	--	--	--	--	--	--
RICE	1	38	2	5	--	--	1	3	--	--	--	--
RILA	--	--	--	--	1	3	1	1	1	3	--	--
ROSA	2	4	--	--	6	7	2	3	2	18	5	40
ROWOU	--	--	--	--	--	--	4	3	4	5	10	20
RUPA	--	--	--	--	--	--	--	--	--	--	--	--
SASC	--	--	1	5	1	13	2	20	4	11	2	40
SHCA	--	--	3	35	4	50	3	8	4	37	3	20
SOSC2	--	--	--	--	--	--	--	--	--	--	--	--
SPBEL	1	4	3	45	4	63	4	39	5	76	4	40
SYAL	1	4	--	--	1	7	2	19	1	13	49	100
SYOR	2	4	--	--	--	--	3	8	--	--	--	--
VACA	--	--	--	--	--	--	--	--	5	32	--	--
VAME	--	--	--	--	1	7	4	3	18	16	--	--
VAMY	--	--	--	--	7	20	2	8	12	68	--	--
VASC	--	--	--	--	2	10	--	--	4	3	--	--
ACMI	2	85	2	65	1	37	2	50	1	24	1	50
ACRU	--	--	--	--	--	--	--	--	--	--	--	--
ADBI	--	--	--	--	--	--	--	--	--	--	--	--
AGIN	30	96	11	35	--	--	15	1	--	--	--	--
ANMI	3	38	6	10	3	7	2	11	--	--	1	10
ANUM	2	23	2	55	2	27	1	8	1	3	--	--
ANRA	1	4	--	--	3	53	5	32	5	39	--	--
AQUIL	--	--	--	--	--	--	1	1	--	--	--	--
ARCO	1	4	2	35	3	43	6	74	6	39	5	60
ASCO	--	--	--	--	--	--	2	19	3	11	4	20
ASTER	--	--	--	--	--	--	2	19	--	--	2	30
ASMI	1	4	3	15	6	13	9	14	10	21	3	10
BASA	10	73	1	15	--	--	3	4	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOCIATION

	PIPO-PSME/AGIN (26 PLOTS)		PSME/ARUV-PUTR (20 PLOTS)		PSME/ARUV (30 PLOTS)		PSME/CARU (74 PLOTS)		PSME/VACCI (38 PLOTS)		PSME/SYAL (10 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
BROMU	1	4	--	--	--	--	1	7	2	3	6	20
BRTE	2	54	--	--	--	--	2	4	--	--	--	--
CACO	--	--	2	40	4	47	3	38	3	39	1	10
CAREX	--	--	4	15	1	3	--	--	2	5	2	10
CARO	2	31	2	50	2	33	4	32	4	24	1	10
CARU	6	62	15	90	17	87	46	100	33	100	10	80
CASTE	--	--	--	--	2	7	1	5	--	--	--	--
CLUN	--	--	--	--	--	--	--	--	--	--	--	--
COPA	2	65	1	45	1	10	2	23	1	8	--	--
CRAT	2	69	1	25	--	--	2	8	--	--	--	--
DITR	--	--	--	--	--	--	1	1	--	--	--	--
EQUIS	--	--	--	--	--	--	--	--	--	--	1	10
FEID	16	73	8	15	3	7	6	7	--	--	--	--
FEOC	4	8	--	--	--	--	3	8	2	11	5	20
FRAGA	2	12	1	10	1	10	2	35	2	47	2	60
GATR	--	--	--	--	--	--	--	--	2	3	--	--
GOOB	--	--	--	--	--	--	1	12	1	8	3	10
HIAL	3	8	2	45	1	33	2	36	2	45	1	20
KOCR	3	58	3	30	5	3	2	5	--	--	--	--
LICHE	--	--	--	--	--	--	--	--	--	--	--	--
LUNA2	--	--	--	--	--	--	1	1	--	--	7	30
LULA	--	--	--	--	--	--	14	22	8	8	--	--
LUSE	6	54	2	10	--	--	5	28	7	8	1	10
MITEL	--	--	--	--	--	--	--	--	--	--	--	--
OSCH	--	--	--	--	--	--	2	12	2	16	2	80
PEPR	1	42	1	70	1	17	1	9	--	--	2	10
PONE	2	12	4	25	8	3	5	9	--	--	--	--
POA	5	8	3	5	2	10	3	4	--	--	--	--
SMRA	1	4	--	--	--	--	1	9	1	3	2	10
SMST	--	--	--	--	1	3	2	3	2	5	--	--
STAM	--	--	--	--	--	--	--	--	--	--	--	--
THOC	--	--	--	--	1	3	3	24	2	8	4	30
VIGL	--	--	--	--	--	--	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOCIATION

	PSME/SYOR (13 PLOTS)		PSME/PAMY (15 PLOTS)		PSME/PHMA (11 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS
ABLA2O	--	--	--	--	--	--
LAOC O	3	15	--	--	12	91
PIAL O	--	--	--	--	--	--
PICO O	--	--	--	--	2	27
PIPO O	17	85	12	93	1	18
PIEN O	--	--	--	--	--	--
POTR O	--	--	3	13	--	--
PSME O	35	92	42	100	41	100
ABLA2U	--	--	1	7	--	--
LAOC U	1	8	--	--	1	9
PIAL U	--	--	--	--	--	--
PICO U	--	--	--	--	1	9
PIPO U	3	31	1	13	--	--
PIEN U	--	--	--	--	--	--
PSME U	3	85	3	93	8	91
ACGLD	4	23	--	--	1	9
ALSI	--	--	--	--	--	--
AMAL	4	77	5	87	4	73
ARUV	1	8	3	13	4	64
BEAQ	6	38	2	60	2	27
CEVE	1	8	2	13	--	--
CHUMO	--	--	1	7	--	--
COCA	--	--	--	--	1	9
HODI	2	15	1	20	5	18
LEGL	--	--	--	--	--	--
LIBOL	5	8	--	--	2	36
LOUT	--	--	--	--	2	9
PAMY	4	38	20	100	2	36
PHEM	--	--	--	--	--	--
PHMA	1	8	--	--	24	91
PUTR	7	23	--	--	--	--
PYSE	--	--	1	13	1	9
RHAL	--	--	--	--	--	--
RICE	3	15	--	--	--	--
RILA	--	--	--	--	--	--
ROSA	2	31	5	33	2	73
ROWOU	4	15	2	7	--	--
RUPA	1	8	2	7	1	18
SASC	2	15	2	40	3	18
SHCA	--	--	--	--	1	36
SOSC2	--	--	1	7	--	--
SPBEL	6	54	10	100	13	82
SYAL	38	69	17	47	5	55
SYOR	16	31	3	7	1	9
VACA	--	--	--	--	--	--
VAME	--	--	--	--	2	9
VAMY	--	--	--	--	--	--
VASC	--	--	--	--	--	--
ACMI	3	62	2	20	2	27
ACRU	--	--	--	--	--	--
ADBI	--	--	--	--	--	--
AGIN	3	23	3	7	1	9
ANMI	--	--	--	--	--	--
ANUM	1	15	--	--	--	--
ANRA	--	--	3	27	3	55
AQUIL	--	--	--	--	--	--
ARCO	3	23	2	33	7	55
ASCO	10	15	2	47	1	9
ASTER	2	23	2	20	1	36
ASMI	1	8	--	--	1	9
BASA	15	31	1	7	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOCIATION

	PSME/SYOR (13 PLOTS)		PSME/PAMY (15 PLOTS)		PSME/PHMA (11 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS
BROMU	6	8	--	--	--	--
BRTE	2	15	--	--	--	--
CACO	1	8	3	13	3	27
CAREX	--	--	1	7	--	--
CARO	1	23	2	13	2	27
CARU	9	85	10	80	32	100
CASTE	1	8	--	--	2	9
CLUN	--	--	--	--	--	--
COPA	2	62	1	7	2	9
CRAT	3	31	--	--	--	--
DITR	2	8	2	40	3	55
EQUIS	--	--	--	--	--	--
FEID	6	23	--	--	1	9
FEOC	--	--	3	13	3	18
FRAGA	3	31	1	20	4	91
GATR	--	--	--	--	--	--
GOOB	2	8	2	47	1	18
HIAL	2	15	2	13	2	18
KOCR	3	31	--	--	--	--
LICHE	--	--	--	--	--	--
LUNA2	--	--	--	--	--	--
LULA	--	--	3	47	--	--
LUSE	8	31	--	--	3	9
MITEL	--	--	--	--	--	--
OSCH	1	8	1	20	--	--
PEPR	1	23	--	--	--	--
PONE	2	8	1	7	--	--
POA	--	--	--	--	1	9
SMRA	3	31	2	20	4	9
SMST	1	8	--	--	1	27
STAM	--	--	--	--	--	--
THOC	--	--	2	33	2	27
VIGL	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOSIATION

	ABLA2/VACCI (36 PLOTS)		ABLA2/LIBOL (45 PLOTS)		ABLA2/PAMY (31 PLOTS)		ABLA2/VASC/CARU (8 PLOTS)		ABLA2/CARU (12 PLOTS)		ABLA2/VASC (27 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
ABLA2O	7	50	17	71	9	35	4	88	9	83	7	44
LAOC O	18	86	18	53	--	--	5	13	13	17	5	4
PIAL O	--	--	--	--	--	--	2	13	1	8	3	22
PICO O	22	78	12	53	16	52	15	75	16	33	34	93
PIPO O	5	8	1	2	8	42	--	--	5	8	--	--
PIEN O	15	64	22	84	15	35	20	25	1	17	15	70
POTR O	1	3	3	2	10	10	--	--	--	--	--	--
PSME O	17	83	21	78	31	97	36	88	42	92	2	4
ABLA2U	6	56	11	67	4	81	4	100	6	67	5	81
LAOC U	2	14	2	4	--	--	1	13	--	--	5	4
PIAL U	1	6	1	4	--	--	--	--	1	17	3	30
PICO U	4	31	1	7	--	--	3	50	2	25	2	26
PIPO U	1	6	--	--	--	--	--	--	1	8	--	--
PIEN U	5	53	4	76	2	65	6	38	1	8	4	78
PSME U	9	78	4	44	3	68	5	63	5	83	2	7
ACGLD	2	8	5	9	2	35	--	--	--	--	--	--
ALSI	13	28	2	7	2	3	--	--	--	--	2	7
AMAL	2	39	2	29	3	61	2	25	1	8	--	--
ARUV	6	69	4	9	2	6	4	25	1	17	--	--
BEAQ	3	11	5	11	4	26	--	--	--	--	--	--
CEVE	--	--	--	--	1	3	--	--	--	--	--	--
CHUMD	3	64	3	53	4	39	--	--	1	33	--	--
COCA	7	33	11	22	20	3	--	--	--	--	--	--
HODI	1	3	3	2	3	6	--	--	--	--	--	--
LEGL	6	6	1	2	--	--	--	--	--	--	3	33
LIBOL	15	83	11	58	6	3	3	25	--	--	5	7
LOUT	3	25	4	22	--	--	1	13	1	17	2	4
PAMY	4	67	3	67	27	100	2	88	2	92	3	11
PHEM	--	--	--	--	--	--	--	--	--	--	--	--
PHMA	--	--	2	4	--	--	--	--	--	--	--	--
PUTR	--	--	--	--	--	--	--	--	--	--	--	--
PYSE	2	53	3	82	2	52	2	25	2	50	1	22
RHAL	--	--	2	4	--	--	--	--	--	--	2	15
RICE	--	--	--	--	--	--	--	--	--	--	--	--
RILA	2	14	2	44	3	10	--	--	--	--	--	--
ROSA	2	3	4	2	4	13	--	--	--	--	--	--
ROWOU	--	--	2	2	--	--	--	--	--	--	--	--
RUPA	4	11	3	22	4	32	--	--	--	--	--	--
SASC	2	3	6	4	3	58	--	--	2	25	--	--
SHCA	5	14	3	13	6	26	1	13	1	8	--	--
SOSC2	--	--	3	13	5	10	--	--	--	--	--	--
SPBEL	4	33	5	16	10	71	4	88	3	25	--	--
SYAL	2	31	3	33	9	26	--	--	--	--	--	--
SYOR	--	--	--	--	--	--	--	--	2	17	--	--
VACA	4	36	--	--	--	--	--	--	--	--	--	--
VAME	6	28	3	11	3	48	7	63	2	17	1	7
VAMY	18	33	3	20	1	6	12	50	1	8	15	52
VASC	17	50	2	20	2	3	11	63	--	--	33	96
ACMI	1	3	1	2	--	--	--	--	2	42	2	4
ACRU	--	--	1	9	2	6	--	--	--	--	--	--
ADBI	--	--	1	11	2	29	--	--	1	8	--	--
AGIN	--	--	--	--	--	--	--	--	--	--	--	--
ANMI	1	3	--	--	--	--	--	--	--	--	--	--
ANUM	2	6	--	--	--	--	1	13	--	--	--	--
ANRA	3	19	2	11	2	16	3	88	7	75	2	11
AQUIL	1	6	2	13	--	--	--	--	1	8	2	11
ARCO	3	44	3	47	2	23	9	75	5	67	3	59
ASCO	3	17	3	18	3	42	--	--	2	25	--	--
ASTER	--	--	2	11	2	23	--	--	7	50	1	7
ASMI	4	6	--	--	--	--	10	13	--	--	--	--
BASA	--	--	--	--	--	--	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOSIATION

	ABLA2/VACCI (36 PLOTS)		ABLA2/LIBOL (45 PLOTS)		ABLA2/PAMY (31 PLOTS)		ABLA2/VASC/CARU (8 PLOTS)		ABLA2/CARU (12 PLOTS)		ABLA2/VASC (27 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
BROMU	2	6	4	31	4	3	--	--	3	8	1	4
BRTE	--	--	--	--	--	--	--	--	--	--	--	--
CACO	4	58	3	24	10	3	2	63	3	42	3	33
CAREX	--	--	2	11	1	23	1	13	3	25	2	7
CARO	2	14	2	16	--	--	3	50	1	25	2	7
CARU	21	72	5	38	12	71	33	100	39	100	2	11
CASTE	--	--	3	2	--	--	1	13	1	8	--	--
CLUN	15	3	4	11	6	16	--	--	--	--	--	--
COPA	--	--	--	--	--	--	--	--	1	25	--	--
CRAT	--	--	--	--	--	--	--	--	--	--	--	--
DITR	--	--	2	11	7	26	--	--	--	--	--	--
EQUIS	1	3	--	--	1	3	--	--	--	--	--	--
FEID	--	--	--	--	--	--	--	--	--	--	--	--
FEOC	3	28	4	22	3	6	2	25	2	25	--	--
FRAGA	3	61	3	36	1	16	2	25	2	17	2	15
GATR	2	6	2	33	2	13	--	--	--	--	--	--
GOOB	2	14	2	40	2	65	1	25	2	50	--	--
HIAL	2	36	2	33	2	26	1	63	4	42	1	4
KOCR	--	--	--	--	--	--	--	--	--	--	--	--
LICHE	2	8	--	--	--	--	--	--	--	--	11	11
LUNA2	--	--	--	--	--	--	--	--	4	17	1	4
LULA	7	19	18	4	3	13	17	63	12	75	7	30
LUSE	7	3	--	--	--	--	--	--	4	17	--	--
MITEL	5	3	2	16	--	--	1	13	2	17	--	--
OSCH	1	33	2	44	3	29	1	25	3	42	2	7
PEPR	--	--	--	--	--	--	1	13	--	--	1	7
PONE	--	--	--	--	--	--	2	13	1	33	--	--
POA	--	--	4	2	--	--	--	--	--	--	--	--
SMRA	1	8	1	18	3	10	--	--	1	8	--	--
SMST	2	14	2	24	2	26	--	--	--	--	--	--
STAM	--	--	--	--	--	--	--	--	--	--	--	--
THOC	2	25	3	49	4	35	--	--	10	42	4	7
VIGL	5	3	4	18	5	6	--	--	--	--	3	4
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOCIATION

	ABLA2/RHAL		PIEN/EQUIS		ABLA2/PHEM		PIAL/CARU		POTR/SYAL		POTR/CARU	
	(24 PLOTS)		(5 PLOTS)		(3 PLOTS)		(6 PLOTS)		(1 PLOTS)		(2 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
ABLA2O	15	96	1	20	7	100	7	50	--	--	--	--
LAOC O	--	--	5	20	--	--	--	--	1	100	5	50
PIAL O	4	8	--	--	8	100	13	100	--	--	--	--
PICO O	20	50	2	20	30	33	8	17	--	--	15	50
PIPO O	--	--	--	--	--	--	--	--	--	--	--	--
PIEN O	23	96	44	100	10	100	5	17	--	--	--	--
POTR O	--	--	15	20	--	--	--	--	95	100	53	100
PSME O	15	33	2	60	--	--	15	50	--	--	--	--
ABLA2U	13	100	2	40	4	100	1	17	--	--	--	--
LAOC U	--	--	--	--	--	--	--	--	--	--	--	--
PIAL U	1	17	--	--	2	100	2	83	--	--	--	--
PICO U	2	13	--	--	1	33	--	--	--	--	2	50
PIPO U	--	--	--	--	--	--	--	--	2	100	--	--
PIEN U	4	50	4	100	2	100	2	17	--	--	--	--
PSME U	1	4	1	20	--	--	--	--	3	100	--	--
ACGLD	1	4	--	--	--	--	--	--	--	--	--	--
ALSI	1	8	13	60	--	--	--	--	--	--	--	--
AMAL	2	4	--	--	--	--	--	--	3	100	--	--
ARUV	--	--	--	--	--	--	--	--	--	--	--	--
BEAQ	1	4	--	--	--	--	--	--	--	--	--	--
CEVE	--	--	--	--	--	--	--	--	--	--	--	--
CHUMO	2	17	--	--	--	--	--	--	--	--	--	--
COCA	5	4	7	100	--	--	--	--	--	--	--	--
HODI	--	--	--	--	--	--	--	--	--	--	--	--
LEGL	15	58	3	40	4	67	--	--	--	--	--	--
LIBOL	10	13	7	80	--	--	--	--	--	--	--	--
LOUT	1	4	2	20	--	--	--	--	--	--	--	--
PAMY	4	33	--	--	--	--	2	67	--	--	5	50
PHEM	1	4	--	--	25	100	--	--	--	--	--	--
PHMA	--	--	--	--	--	--	--	--	--	--	--	--
PUTR	--	--	--	--	--	--	--	--	--	--	--	--
PYSE	2	54	2	60	--	--	--	--	--	--	--	--
RHAL	28	79	--	--	2	33	--	--	--	--	--	--
RICE	--	--	--	--	--	--	1	17	--	--	--	--
RILA	3	46	7	100	--	--	--	--	--	--	--	--
ROSA	--	--	1	20	--	--	--	--	5	100	--	--
ROWOU	--	--	1	20	--	--	--	--	--	--	--	--
RUPA	1	4	3	20	--	--	--	--	--	--	--	--
SASC	1	4	2	20	--	--	--	--	--	--	--	--
SHCA	2	8	1	20	--	--	--	--	--	--	5	50
SOSC2	5	4	--	--	--	--	--	--	--	--	--	--
SPBEL	4	17	--	--	--	--	--	--	--	--	--	--
SYAL	--	--	4	40	--	--	--	--	60	100	--	--
SYOR	--	--	--	--	--	--	--	--	--	--	2	50
VACA	--	--	--	--	--	--	--	--	--	--	--	--
VAME	18	25	--	--	--	--	3	17	--	--	--	--
VAMY	5	38	1	20	--	--	--	--	--	--	--	--
VASC	21	88	--	--	17	100	3	50	--	--	--	--
ACMI	1	4	--	--	--	--	5	100	--	--	5	50
ACRU	2	4	7	40	--	--	--	--	1	100	--	--
ADBI	6	4	--	--	--	--	--	--	--	--	--	--
AGIN	--	--	--	--	--	--	--	--	--	--	--	--
ANMI	--	--	--	--	--	--	--	--	--	--	--	--
ANUM	--	--	--	--	--	--	5	17	--	--	--	--
ANRA	4	17	--	--	--	--	3	17	--	--	--	--
AQUIL	4	8	--	--	--	--	2	17	--	--	--	--
ARCO	4	50	3	20	--	--	2	33	--	--	--	--
ASCO	2	8	--	--	--	--	--	--	--	--	5	50
ASTER	3	25	5	40	--	--	4	50	--	--	--	--
ASMI	--	--	--	--	--	--	--	--	--	--	30	50
BASA	--	--	--	--	--	--	--	--	--	--	1	50
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

MEAN COVER AND CONSTANCY BY ASSOCIATION

	ABLA2/RHAL (24 PLOTS)		PIEN/EQUIS (5 PLOTS)		ABLA2/PHEM (3 PLOTS)		PIAL/CARU (6 PLOTS)		POTR/SYAL (1 PLOTS)		POTR/CARU (2 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
BROMU	6	8	1	20	--	--	--	--	10	100	--	--
BRTE	--	--	--	--	--	--	--	--	--	--	--	--
CACO	4	33	5	20	--	--	3	17	--	--	--	--
CAREX	6	21	6	80	--	--	2	50	2	100	--	--
CARO	--	--	--	--	--	--	6	67	--	--	--	--
CARU	8	25	--	--	--	--	10	100	--	--	80	100
CASTE	--	--	--	--	--	--	2	50	--	--	--	--
CLUN	--	--	--	--	--	--	--	--	--	--	--	--
COPA	--	--	--	--	--	--	--	--	--	--	--	--
CRAT	--	--	--	--	--	--	--	--	--	--	--	--
DITR	--	--	2	40	--	--	--	--	1	100	--	--
EQUIS	3	4	42	100	--	--	--	--	--	--	--	--
FEID	--	--	--	--	--	--	6	50	--	--	--	--
FEOC	5	4	5	20	--	--	--	--	--	--	--	--
FRAGA	2	29	3	60	--	--	5	17	--	--	--	--
GATR	1	4	3	80	--	--	--	--	--	--	--	--
GOOB	2	29	1	20	--	--	--	--	--	--	--	--
HIAL	3	8	--	--	--	--	--	--	--	--	--	--
KOCR	--	--	--	--	--	--	3	33	--	--	--	--
LICHE	--	--	--	--	13	67	--	--	--	--	--	--
LUNA2	--	--	--	--	--	--	6	33	--	--	--	--
LULA	4	29	--	--	--	--	16	33	--	--	6	100
LUSE	--	--	--	--	--	--	6	33	--	--	--	--
MITEL	2	21	6	80	--	--	--	--	--	--	--	--
OSCH	2	29	5	20	--	--	--	--	7	100	--	--
PEPR	--	--	--	--	--	--	--	--	--	--	--	--
PONE	--	--	--	--	--	--	1	17	--	--	--	--
POA	--	--	--	--	--	--	7	50	--	--	--	--
SMRA	--	--	--	--	--	--	--	--	--	--	--	--
SMST	3	8	3	80	--	--	--	--	2	100	--	--
STAM	5	8	2	60	--	--	--	--	--	--	--	--
THOC	5	21	6	40	--	--	--	--	3	100	30	100
VIGL	3	4	6	40	--	--	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

APPENDIX E

MEAN AND CONSTANCY SUMMARY

OF PRODUCTIVITY INFORMATION BY ASSOCIATION

PRODUCTIVITY SUMMARY BY ASSOCIATION

	PIPO-PSME/AGIN (15 PLOTS)		PSME/ARUV-PUTR (10 PLOTS)		PSME/ARUV (8 PLOTS)		PSME/CARU (39 PLOTS)		PSME/VACCI (14 PLOTS)		PSME/SYAL (5 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
HERBGE	250	100	74	100	64	88	199	100	77	100	66	80
SDI	93	100	176	100	290	100	276	100	278	100	310	100
SDICU	12	100	22	100	20	100	36	100	37	100	72	100
TBA	56	100	99	100	153	100	179	100	152	100	196	100
DFN	4	40	4	70	4	100	4	90	4	86	4	100
DFGBA	97	40	84	70	120	100	178	90	144	86	314	100
DFSI	65	40	66	70	57	100	77	90	73	86	98	100
DFAGE	115	40	123	70	254	100	146	90	148	86	72	100
DFCU	32	40	28	70	35	100	68	90	56	86	153	100
LPN	--	--	5	10	4	50	3	10	4	71	--	--
LPGBA	--	--	118	10	140	50	150	10	145	71	--	--
LPSI	--	--	38	10	27	50	39	10	45	71	--	--
LPAGE	--	--	127	10	125	50	116	10	95	71	--	--
LPCU	--	--	22	10	33	50	49	10	52	64	--	--
PPN	4	100	4	100	3	50	4	36	2	7	5	100
PPGBA	71	100	98	100	147	50	140	36	119	7	258	100
PPSI	68	100	70	100	59	50	78	36	70	7	100	100
PPAGE	151	100	170	100	287	50	161	36	147	7	90	100
PPCU	25	100	35	100	43	50	51	36	42	7	129	100
WLN	--	--	--	--	5	13	4	41	4	86	--	--
WLGBA	--	--	--	--	118	25	138	41	119	86	--	--
WLSI	--	--	--	--	43	25	55	41	53	86	--	--
WLAGE	--	--	--	--	147	25	151	41	145	86	--	--
WLCU	--	--	--	--	41	25	60	41	49	86	--	--
ESN	--	--	--	--	--	--	--	--	--	--	--	--
ESGBA	--	--	--	--	--	--	--	--	--	--	--	--
ESSI	--	--	--	--	--	--	--	--	--	--	--	--
ESAGE	--	--	--	--	--	--	--	--	--	--	--	--
ESCU	--	--	--	--	--	--	--	--	--	--	--	--
SAN	--	--	--	--	--	--	--	--	--	--	--	--
SAGBA	--	--	--	--	--	--	--	--	--	--	--	--
SASI	--	--	--	--	--	--	--	--	--	--	--	--
SAAGE	--	--	--	--	--	--	--	--	--	--	--	--
SACU	--	--	--	--	--	--	--	--	--	--	--	--
PSN	--	--	--	--	--	--	--	--	--	--	--	--
PSGBA	--	--	--	--	--	--	--	--	--	--	--	--
PSSI	--	--	--	--	--	--	--	--	--	--	--	--
PSAGE	--	--	--	--	--	--	--	--	--	--	--	--
PSCU	--	--	--	--	--	--	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

PRODUCTIVITY SUMMARY BY ASSOCIATION

	PSME/SYOR		PSME/PAMY		PSME/PHMA		ABLA2/VACCI		ABLA2/LIBOL		ABLA2/PAMY	
	(7 PLOTS)		(6 PLOTS)		(4 PLOTS)		(22 PLOTS)		(22 PLOTS)		(7 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
HERBGE	110	100	27	100	71	100	44	95	30	95	28	86
SDI	189	100	379	100	268	100	404	100	443	100	376	100
SDICU	31	100	64	100	31	100	58	100	92	100	79	100
TBA	112	100	224	100	158	100	198	100	238	100	223	100
DFN	4	86	5	100	5	100	4	68	4	73	4	100
DFGBA	136	86	225	100	166	100	211	68	250	73	268	100
DFSI	82	86	86	100	73	100	79	68	86	73	102	100
DFAGE	99	86	102	100	148	100	148	68	158	73	100	100
DFCU	56	86	100	100	60	100	84	68	107	73	138	100
LPN	--	--	--	--	--	--	4	64	3	18	3	14
LPGBA	--	--	--	--	--	--	173	64	177	18	238	14
LPSI	--	--	--	--	--	--	46	64	50	18	50	14
LPAGE	--	--	--	--	--	--	95	64	120	18	79	14
LPCU	--	--	--	--	--	--	67	64	70	18	101	14
PPN	4	57	3	50	--	--	--	--	--	--	2	14
PPGBA	114	57	183	50	--	--	--	--	--	--	103	14
PPSI	80	57	88	50	--	--	--	--	--	--	83	14
PPAGE	116	57	160	50	--	--	--	--	--	--	251	14
PPCU	46	57	81	50	--	--	--	--	--	--	43	14
WLN	--	--	--	--	3	25	4	73	4	41	--	--
WLGBA	--	--	--	--	134	25	173	73	243	41	--	--
WLSI	--	--	--	--	50	25	57	73	67	41	--	--
WLAGE	--	--	--	--	130	25	158	73	174	41	--	--
WLCU	--	--	--	--	54	25	80	73	133	41	--	--
ESN	--	--	--	--	--	--	5	23	4	86	3	14
ESGBA	--	--	--	--	--	--	180	23	277	86	313	14
ESSI	--	--	--	--	--	--	54	23	66	86	85	14
ESAGE	--	--	--	--	--	--	104	23	135	86	110	14
ESCU	--	--	--	--	--	--	73	23	131	86	202	14
SAN	--	--	--	--	--	--	4	23	3	55	3	14
SAGBA	--	--	--	--	--	--	184	23	218	55	138	14
SASI	--	--	--	--	--	--	90	23	92	55	80	14
SAAGE	--	--	--	--	--	--	86	23	127	55	85	14
SACU	--	--	--	--	--	--	84	23	101	55	55	14
PSN	--	--	--	--	--	--	--	--	--	--	--	--
PSGBA	--	--	--	--	--	--	--	--	--	--	--	--
PSSI	--	--	--	--	--	--	--	--	--	--	--	--
PSAGE	--	--	--	--	--	--	--	--	--	--	--	--
PSCU	--	--	--	--	--	--	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

PRODUCTIVITY SUMMARY BY ASSOCIATION

	ABLA2/VASC/CARU (5 PLOTS)		ABLA2/CARU (7 PLOTS)		ABLA2/VASC (12 PLOTS)		ABLA2/RHAL (12 PLOTS)		PIEN/EQUIS (4 PLOTS)		ABLA2/PHEM (3 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
HERBGE	331	100	253	100	11	100	79	92	315	75	7	100
SDI	284	100	366	100	417	100	384	100	312	100	230	100
SDICU	23	100	55	100	27	100	50	100	69	100	6	100
TBA	169	100	230	100	209	100	197	100	218	100	114	100
DFN	4	100	4	100	--	--	4	25	--	--	--	--
DFGBA	156	100	207	100	--	--	167	25	--	--	--	--
DFSI	63	100	82	100	--	--	67	25	--	--	--	--
DFAGE	198	100	152	100	--	--	206	25	--	--	--	--
DFCU	49	100	85	100	--	--	57	25	--	--	--	--
LPN	4	60	4	43	5	100	4	33	--	--	--	--
LPGBA	117	60	201	43	173	100	185	33	--	--	--	--
LPSI	32	60	48	43	31	100	35	33	--	--	--	--
LPAGE	128	60	111	43	143	100	130	33	--	--	--	--
LPCU	35	60	80	43	49	100	56	33	--	--	--	--
PPN	--	--	--	--	--	--	--	--	--	--	--	--
PPGBA	--	--	--	--	--	--	--	--	--	--	--	--
PPSI	--	--	--	--	--	--	--	--	--	--	--	--
PPAGE	--	--	--	--	--	--	--	--	--	--	--	--
PPCU	--	--	--	--	--	--	--	--	--	--	--	--
WLN	--	--	3	29	--	--	--	--	--	--	--	--
WLGBA	--	--	171	29	--	--	--	--	--	--	--	--
WLSI	--	--	59	29	--	--	--	--	--	--	--	--
WLAGE	--	--	157	29	--	--	--	--	--	--	--	--
WLCU	--	--	82	29	--	--	--	--	--	--	--	--
ESN	2	20	--	--	5	42	4	83	5	100	--	--
ESGBA	179	20	--	--	203	42	191	83	244	100	--	--
ESSI	55	20	--	--	36	42	51	83	64	100	--	--
ESAGE	89	20	--	--	184	42	210	83	110	100	--	--
ESCU	71	20	--	--	64	42	75	83	122	100	--	--
SAN	2	20	4	29	--	--	4	67	--	--	--	--
SAGBA	169	20	165	29	--	--	154	67	--	--	--	--
SASI	50	20	67	29	--	--	72	67	--	--	--	--
SAAGE	95	20	114	29	--	--	181	67	--	--	--	--
SACU	42	20	56	29	--	--	55	67	--	--	--	--
PSN	--	--	--	--	--	--	--	--	--	--	--	--
PSGBA	--	--	--	--	--	--	--	--	--	--	--	--
PSSI	--	--	--	--	--	--	--	--	--	--	--	--
PSAGE	--	--	--	--	--	--	--	--	--	--	--	--
PSCU	--	--	--	--	--	--	--	--	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

PRODUCTIVITY SUMMARY BY ASSOCIATION

	PIAL/CARU		ABAM/PAMY		ABAM/RHAL		POTR/SYAL		POTR/CARU	
	(6 PLOTS)		(2 PLOTS)		(3 PLOTS)		(1 PLOTS)		(2 PLOTS)	
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS
HERBGE	112	100	24	100	2	100	21	100	1212	100
SDI	96	100	372	100	393	100	535	100	280	50
SDICU	3	100	75	100	56	100	106	100	27	50
TBA	59	100	269	100	268	100	188	100	164	50
DFN	5	17	5	100	4	33	--	--	--	--
DFGBA	160	17	281	100	223	33	--	--	--	--
DFSI	52	17	93	100	92	33	--	--	--	--
DFAGE	121	17	221	100	210	33	--	--	--	--
DFCU	42	17	142	100	102	33	--	--	--	--
LPN	--	--	--	--	--	--	--	--	3	50
LPGBA	--	--	--	--	--	--	--	--	189	50
LPSI	--	--	--	--	--	--	--	--	48	50
LPAGE	--	--	--	--	--	--	--	--	49	50
LPCU	--	--	--	--	--	--	--	--	73	50
PPN	--	--	--	--	--	--	--	--	--	--
PPGBA	--	--	--	--	--	--	--	--	--	--
PPSI	--	--	--	--	--	--	--	--	--	--
PPAGE	--	--	--	--	--	--	--	--	--	--
PPCU	--	--	--	--	--	--	--	--	--	--
WLN	--	--	--	--	--	--	1	100	2	50
WLGBA	--	--	--	--	--	--	120	100	115	50
WLSI	--	--	--	--	--	--	60	100	55	50
WLAGE	--	--	--	--	--	--	118	100	137	50
WLCU	--	--	--	--	--	--	62	100	52	50
ESN	--	--	2	50	4	33	--	--	--	--
ESGBA	--	--	279	50	189	33	--	--	--	--
ESSI	--	--	70	50	83	33	--	--	--	--
ESAGE	--	--	200	50	201	33	--	--	--	--
ESCU	--	--	206	50	117	33	--	--	--	--
SAN	--	--	3	50	--	--	--	--	--	--
SAGBA	--	--	246	50	--	--	--	--	--	--
SASI	--	--	73	50	--	--	--	--	--	--
SAAGE	--	--	115	50	--	--	--	--	--	--
SACU	--	--	90	50	--	--	--	--	--	--
PSN	--	--	--	--	5	67	--	--	--	--
PSGBA	--	--	--	--	234	67	--	--	--	--
PSSI	--	--	--	--	67	33	--	--	--	--
PSAGE	--	--	--	--	285	67	--	--	--	--
PSCU	--	--	--	--	76	67	--	--	--	--
	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS	MEAN	CONS

APPENDIX F

SITE INDEX TABLES

USED IN THE STUDY

Site Index Table - PIPO Dominant and Codominant Trees

SITE INDEX TABLES

Upper Limits of Site Indices 1/
Dominants and Codominant

Site Class		VI		V	IV		III	II		I				
Site Index	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Age (Years)														
20	6	8	10	14	18	22	28	32	38	42	48	52	58	
25	8	10	14	18	24	28	34	40	46	51	56	63	69	
30	11	13	18	23	29	35	41	48	54	60	67	74	80	
35	14	16	22	28	34	40	46	54	60	67	74	82	88	
40	17	19	25	32	38	46	52	59	66	74	81	89	96	
45	19	22	28	36	42	50	57	64	71	79	87	95	102	
50	21	24	32	39	47	54	62	69	76	84	93	101	109	
55	23	27	35	42	50	58	66	73	81	89	98	106	114	
60	25	30	38	46	54	62	70	77	86	94	103	111	120	
65	26	32	40	49	57	65	73	80	90	98	108	116	125	
70	27	34	43	52	60	68	76	84	94	103	112	120	130	
75	28	36	46	54	63	71	80	88	98	107	116	124	134	
80	29	38	48	56	66	74	84	92	102	111	120	128	138	
85	30	40	50	57	68	77	87	96	105	114	124	132	142	
90	31	42	52	62	70	80	90	99	108	118	128	137	147	
95	33	44	54	64	72	82	92	102	112	122	132	141	151	
100	35	45	55	65	75	85	95	105	115	125	135	145	155	
105	36	46	56	66	77	88	98	108	118	128	138	148	159	
110	36	48	58	68	79	90	100	111	122	132	142	152	163	
115	37	49	59	70	80	92	103	114	125	136	146	156	166	
120	37	50	60	72	82	94	106	116	128	140	149	160	170	
125	37	50	62	73	84	96	108	119	131	142	152	163	174	
130	38	51	63	74	86	98	110	122	134	145	156	166	177	
135	38	52	64	76	88	100	112	124	136	148	159	170	180	
140	38	52	65	77	90	102	114	127	139	151	162	173	184	
145	39	53	66	78	91	104	116	130	142	154	165	176	187	
150	39	54	66	80	92	106	118	132	144	157	168	179	190	
155	39	54	67	81	94	108	120	134	147	160	171	182	193	
160	40	54	68	82	96	109	122	136	150	162	174	185	196	
165	40	54	69	83	97	110	124	138	152	165	176	188	198	
170	40	55	70	84	98	112	126	140	154	168	179	190	201	
175	40	56	70	85	99	114	128	142	156	170	182	192	204	
180	40	56	70	86	100	115	129	144	158	172	184	195	206	
185	41	56	70	86	101	116	130	145	160	174	186	198	208	
190	41	56	71	87	102	118	132	146	162	176	188	200	210	
195	41	56	72	88	103	119	134	148	163	178	190	202	212	
200	41	57	72	88	104	120	136	150	164	180	192	204	214	
Cubic-foot site class	7		6		5		4		3		2		1	

Based on: USDA Technical Bulletin No. 630; Yield of Evenaged Stands of Ponderosa Pine; Walter H. Meyer; Revised 1961

1/ Do not interpolate - upper height limits for each age are already shown for each site index.

Site Index Table - PSME Dominant Trees

SITE INDEX TABLES

Upper Limits of Site Indices 3/
Dominants Trees 1/

Site Class		VI		V		IV			III			II			I		
Site Index	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
Age (Years)						Total Height in Feet											
20	15	17	22	25	29	32	34	36	40	42	44	47	50	53	55	58	
25	20	24	30	34	38	42	45	49	54	57	61	65	68	72	75	79	
30	25	30	38	43	48	53	57	63	67	71	77	81	86	92	96	100	
35	29	34	43	49	55	61	65	71	77	81	88	94	98	105	111	115	
40	33	39	49	56	62	68	74	80	87	93	99	106	112	118	124	131	
45	36	42	54	61	67	73	79	87	94	100	107	115	121	128	134	141	
50	39	45	58	65	71	79	86	93	100	109	115	123	130	137	145	151	
55	41	48	60	68	75	84	91	98	107	115	121	130	138	145	153	160	
60	43	50	63	71	79	88	96	103	112	120	128	137	145	153	161	169	
65	46	53	65	74	84	92	100	109	117	128	134	143	151	159	168	176	
70	49	57	68	77	87	96	105	113	121	137	140	149	157	165	175	184	
75	50	58	71	80	90	99	108	117	126	139	145	154	162	171	181	190	
80	50	59	74	84	92	102	111	120	130	141	149	159	167	176	186	196	
85	52	60	76	86	94	105	114	123	134	145	153	163	172	182	192	202	
90	53	62	78	88	97	107	117	128	139	148	157	167	178	187	197	207	
95	54	63	79	90	99	109	119	130	141	151	161	171	182	191	202	211	
100	55	64	80	91	101	112	122	133	144	154	164	174	185	195	206	216	
105	56	65	81	92	102	114	124	135	147	157	167	178	188	199	209	219	
110	57	66	84	94	105	116	127	138	149	159	169	181	192	203	213	223	
115	57	67	85	95	107	117	128	140	151	161	171	184	194	205	216	226	
120	58	68	86	96	108	119	130	142	153	163	174	186	196	208	219	230	
125	59	69	86	97	109	120	132	143	154	165	175	188	199	210	221	232	
130	60	70	87	98	110	121	133	145	155	167	178	190	201	212	223	235	
135	60	70	88	99	111	122	134	146	157	168	180	191	203	213	225	236	
140	60	70	89	100	111	123	135	147	158	169	181	192	205	215	228	238	
145	61	71	89	100	112	124	137	147	159	170	182	193	206	217	229	240	
150	61	71	90	101	113	1216	137	148	160	171	183	194	207	218	230	242	
155	61	72	90	102	113	126	138	149	161	172	184	195	208	219	231	243	
160	62	72	91	102	114	127	139	150	161	173	185	196	209	220	232	244	
165	62	72	91	102	115	128	140	151	163	174	186	196	211	223	234	247	
170	62	73	92	103	115	128	141	153	164	175	188	201	213	225	237	250	
175	64	74	92	105	116	129	142	154	165	178	190	203	215	228	240	253	
180	64	75	93	105	117	130	143	155	167	179	191	204	217	230	242	256	
185	64	75	93	106	118	131	144	156	168	180	192	205	217	230	242	257	
190	65	75	94	107	119	132	145	157	169	181	193	206	218	231	243	257	
200	65	76	96	109	121	134	146	158	170	183	195	208	219	232	244	257	
225	66	77	98	111	123	137	149	161	173	186	200	212	224	237	249	263	
250	68	79	101	114	127	140	152	163	178	190	204	216	230	242	255	268	
275	69	80	102	115	128	142	154	166	180	193	207	219	233	245	258	272	
300	70	82	103	116	130	144	156	169	183	196	210	222	236	248	261	275	
325	71	83	105	117	131	145	157	171	184	199	211	224	238	250	264	278	
350	71	83	106	118	132	146	159	172	186	200	213	226	240	254	267	282	
375	72	84	107	119	133	147	161	173	188	201	215	229	242	257	269	285	
400	72	85	108	120	134	148	162	175	189	203	216	231	244	259	273	288	
2/Cubic-foot site class	7	6		5			4			3					2		

1/ Conversion from dominants and codominants based on report by George R. Stabler, Occasional Paper 44, September 1, 1948.

2/ Cubic-foot site class changes and addition of site indices 50 and 60 made on February 24, 1966 (see memo in 1966 Techniques file).

3/ Do not interpolate - upper height limits for each age are already shown for each site index.

Site Index Table - PICO

Upper Limits of Site Indices [1/]

Age Years	Site Index 10	20	30	40	50	60	70
		Total Height in Feet					
20	8	11	14	18	22	26	
25	10	14	18	23	28	33	
30	12	17	22	28	34	40	
35	14	20	26	32	40	47	
40	15	22	29	37	45	54	
45	17	25	32	41	50	60	
50	19	27	35	45	56	66	
55	20	29	38	49	60	71	
60	22	32	41	53	65	76	
65	24	35	44	56	69	81	
70	26	37	46	59	73	86	
75	27	39	48	62	76	90	
80	28	41	51	65	80	94	
85	29	43	53	68	83	98	
90	30	45	55	70	86	101	
95	31	47	56	72	88	104	
100	32	48	58	74	91	107	
105	32	49	59	76	93	110	
110	33	50	60	78	95	112	
115	33	51	61	79	96	114	
120	34	52	62	80	98	116	
125	35	53	62	81	99	117	
130	35	54	63	82	100	118	
Cubic foot Site class	7	6		5			4

1/ Do not interpolate - upper height limits for each age are already shown for each Site Index.

"Based upon USDA PNW-8 Bulletin by Dahms."

Site Index Table - LAOC [1/]

SITE INDEX TABLES

Stand Age		Average Height of Dominant Stand Site Index - Upper Limits					
		30	40	50	60	70	80
20	Values less than those for Site Index 30	8	10	13	15	17	20
30		18	23	28	34	39	44
40		27	35	43	51	59	67
50		35	45	55	65	75	85
60		41	53	65	76	88	100
70		46	59	72	85	98	112
80		50	65	79	93	108	122
90		54	69	84	100	115	130
100		57	73	89	105	122	138
110		59	76	93	110	127	144
120		61	79	97	114	132	149
130		63	82	90	118	136	154
140		65	84	102	121	140	158
150		66	85	105	124	143	162
160		68	87	107	126	146	165
170		69	89	109	129	149	168
180		70	91	111	131	151	171
190		71	92	112	133	153	173
200		72	93	113	134	155	175
Cubic Foot Site Class	7	6		5		4	3

1/ Unpublished data by Art Roe; compiled by Jim Bricken, Intermountain Experiment Station.

Site Index Table - PIEN

SITE INDEX TABLES

Upper Limits of Site Indices
Dominants and Codominants 1/

Age Years	Site Index 20	30	40	50	60	70	80	90
	Total Height in Feet							
20	7	11	16	22	28	33	37	41
25	10	15	22	28	35	41	47	52
30	13	20	27	35	42	49	55	61
35	16	24	32	40	48	56	64	70
40	19	28	37	46	54	63	71	79
45	22	32	41	50	60	69	78	87
50	25	35	45	55	65	75	85	95
55	28	38	49	59	70	80	91	102
60	30	41	52	63	74	85	97	109
65	32	44	55	66	78	89	102	115
70	34	46	58	69	81	93	107	121
75	36	49	60	72	84	97	111	126
80	38	51	62	74	87	100	115	132
85	39	53	64	76	89	103	119	136
90	40	54	66	78	91	106	122	141
95	42	56	68	80	93	108	126	145
100	43	57	69	81	95	111	129	149
105	44	58	70	83	97	113	131	152
110	45	59	71	84	98	115	134	156
115	45	60	72	85	99	116	136	159
120	46	61	73	86	100	118	138	162
125	47	62	74	87	102	119	140	164
130	47	62	74	87	102	120	141	166
135	48	63	75	88	103	121	143	169
140	48	64	76	89	104	122	145	171
145	49	64	76	89	105	123	146	173
150	49	64	76	90	105	124	147	175
155	49	65	77	90	106	125	148	177
160	50	65	77	90	106	125	149	178
165	50	65	78	91	107	126	150	180
170	50	66	78	91	107	127	151	181
175	50	66	78	91	107	127	152	183
180	50	66	78	92	108	128	152	184
185	51	66	78	92	108	128	153	185
190	51	66	78	92	108	128	154	186
195	51	66	79	92	108	129	154	187
200	51	66	79	92	108	129	155	188

1/ Conversion from data obtained from Intermountain Station, 1965. Unpublished. Memorandum of S. Blair Hutchison, dated May 13, 1965.

Site Index Table - TSHE, TSME, and ABLA2 Dominant and Codominant Trees

SITE INDEX TABLES

Upper Limits of Site Indices -- Dominant and Codominant Trees [1/]

Site Class		VI		V			IV			III			II			I	
Site Index	40	60	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Age (Years)	Total height in feet																
10	2	4	4	4	5	6	6	6	8	8	8	9	10	10	11	12	12
20	9	12	14	16	18	20	22	24	26	28	30	32	34	37	39	41	43
30	17	21	24	28	32	36	40	44	47	51	55	59	63	66	70	74	78
40	23	28	34	39	44	50	54	60	66	70	76	81	86	92	96	102	107
50	29	35	42	48	55	61	67	74	80	86	93	99	106	112	118	124	132
60	34	41	49	56	64	71	79	86	93	101	108	116	123	131	138	145	153
70	37	45	53	61	70	78	86	94	103	111	119	127	136	144	152	160	171
80	39	48	57	66	75	84	93	102	110	119	128	137	147	156	164	173	182
90	42	52	61	71	80	90	99	108	118	128	137	146	156	165	175	185	194
100	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205
110	47	58	68	79	89	99	110	120	131	141	152	162	173	183	194	204	215
120	49	60	70	81	92	103	113	124	135	146	156	167	178	189	190	210	221
130	50	61	72	83	94	105	116	127	138	149	160	171	183	194	205	216	227
140	51	62	74	85	96	107	118	129	141	152	163	174	186	197	208	220	231
150	52	63	75	86	97	109	120	131	143	154	166	177	189	200	212	223	235
160	52	64	76	87	99	110	121	133	145	156	168	179	191	203	214	226	238
180	53	65	77	89	101	112	123	136	148	159	171	183	195	207	219	230	242
200	54	66	78	90	102	113	125	138	150	161	173	186	197	210	221	233	245
220	54	66	78	90	103	114	127	139	151	163	175	187	199	211	224	235	247
240	55	67	79	91	103	115	127	139	152	164	176	188	200	212	225	237	249
260	55	67	79	91	104	116	128	140	152	164	176	188	200	213	225	238	250
280	55	67	80	92	104	116	128	140	153	165	177	189	201	214	226	239	251
300	55	67	80	92	104	117	129	141	153	166	178	190	202	215	227	240	252
Cubic foot Site Class	7	6	5		4		3		2			1					

Based upon USDA Technical Bulletin No. 1273; Yield of Even-Aged Stands of Western Hemlock; George H. Barnes, PNW, 1962.

1/ Do not interpolate - upper height limits already shown for each age for each site index.

APPENDIX G

STAND DENSITY INDEX

PRODUCTIVITY ESTIMATES INSTRUCTIONS

3410

United States Department of Agriculture | Forest Service | RO

Jim O ~~JO~~ c/s | Clint c/s | Gerry c/s

Reply to: 1920 Land and Resource Management Planning
2410 Plans

Okanogan NF, 1981
RECEIVED
MAY 5 1981

Subject: Classification of Timber Production Capability

To: Forest Supervisors and Resources Directors

Jim O
Tim T c/s

As we proceed with Forest Planning, it is increasingly clear that land classification is one of the key elements in the process. One of the first levels of classification is determining the capability for timber production. This level is defined by the minimum biological growth standard in the Regional Plan. At this time, it appears that the Regional Plan will set a minimum biological growth standard of 20 cubic feet per acre per year.

Various techniques have been used for determining annual cubic foot growth potential, but it appears that a method using Stand Density Index (SDI) with reductions for stand stockability offers reliable estimates based on recognized stand relationships and published research information.

This approach, which is described in the enclosed documents, should be used for determining capability for timber production in Forest Planning, as defined in FSM 2415.21--2 and CFR 219.12(b). Forests which have used other techniques should evaluate previous estimates against the SDI method. If significant discrepancies are found, the need for adjustments can be assessed.

James F Torrence
for R. E. WORTHINGTON
Regional Forester

Enclosure

USING REINEKE'S STAND DENSITY INDEX TO ESTIMATE GROWTH CAPABILITY [1]

INTRODUCTION: During the early 1970's, Forest Service inventory specialists were faced with the task of determining the potential timber production of lands which were incapable of carrying normal degrees of stocking. They recognized that in areas of low rainfall, trees require more room than is "normal" to fulfill stocking requirements. Other factors such as soil limitations also affected stockability. The net result was that substantial areas of the forest were not able to carry stocking at normal yield table levels.

In order to recognize these limitations, "yield table estimates of growth were discounted in proportion to the stocking capability. For example, if the information available indicated that only 50 percent stockability was obtainable, then the yield estimate derived from the site tree measurements and yield equations was reduced 50 percent. For the lack of a better basis, it was generally assumed that the existing tree stocking on marginal areas (or the stocking formerly present if the area had been disturbed) is the maximum the land could support" (Wikstrom and Hutchison, 1971). This approach has been used to determine which lands are capable of timber production. [2]

Reineke's Stand Density Index (SDI) (Reineke, 1933) has been found to be an effective measure of relative stocking which can be readily measured from inventory or stand examination data. Initial work on the Siskiyou National Forest and later testing on the Ochoco have resulted in a process using SDI which appears to give reasonable estimates of wood production potential for areas incapable of normal stocking. Many of the techniques are drawn from inventory analysis procedures developed earlier by the Bureau of Land Management. [3]

STAND DENSITY INDEX

SDI is defined as the number of trees per acre that a stand could be expected to have if its quadratic mean diameter were 10 inches. When plotted on logarithmic paper, the curve of maximum number of trees per acre over quadratic mean diameter assumes a straight line. The 10-inch index is used to equate stocking over a range of diameters. Stand Density Index and its application have been well described in forestry literature. (Daniel et al, 1979a) (P. 262, Daniel et al, 1979b) Although SDI was originally developed from pure, even-aged stands, it also has application to uneven aged conditions (Stage, 1968) and to stands of mixed species composition (Daniel et al, 1979a).

1/Prepared by Walter H. Knapp, Silviculturist, Pacific Northwest Region, USDA Forest Service, Portland, Oregon. April, 1981.
2/ Capability has been historically defined as a potential productivity of at least 20 cubic feet per acre per year.
3/ USDI, Bureau of Land Management, unpublished document, undated. Using Stand Density Index to estimate forest productivity in marginal areas (southwestern Oregon version). Copy on file, USDA Forest Service, Portland, Oregon.

Stand Density Index equations have been developed for many of the western conifers, using data from normal yield tables. Some of the more useful relationships and their sources are shown in the following equations:

SPECIES	EQUATION [4]		SOURCE
Mixed Conifer	$SDI = 10^{(\log N + 1.605 \log D - 1.605)}$	(1)	Reineke, 1933
Douglas-fir	$SDI = 10^{(\log N + 1.55 \log D - 1.55)}$	(2)	Curtis, 1971
Ponderosa Pine	$SDI = 10^{(\log N + 1.80 \log D - 1.80)}$	(3)	MacLean and Bolsinger, 1973

...where SDI = Stand Density Index, N = number of trees per acre, and D = average stand diameter (diameter of tree of mean basal area).

Plot data from various sources show that most west coast tree species fit one of these three equations. The mixed conifer equation (1) is suitable for typical mixed conifer stands and for stands of true fir, hemlock, Englemann and Sitka spruce, western white pine, and western redcedar. It should also be used in situations where other equations do not apply.

The Douglas-fir equation (2) is suitable for relatively pure stands of Douglas-fir; i.e., those with at least 80 percent Douglas-fir stocking. The Ponderosa pine equation (3) is suitable for ponderosa, Jeffrey, and lodgepole pine stands.

SDI values have been developed for the major species and species groups, using empirical data from normally-stocked stands:

SPECIES (secondary species)	NORMAL SDI	SOURCE
DOUGLAS-FIR (sugar pine) (incense-cedar)	370	McArdle et al., 1961
PONDEROSA PINE (Jeffrey pine)	370	Meyer, W. H. 1938
WHITE FIR (grand fir)	565	Schumacher, 1926
MIXED CONIFER	370	Dunning and Reinke, 1933
WESTERN HEMLOCK (mountain hemlock) (true firs except white and grand) (western white pine) (cedars except incense)	498	Barnes, 1962
LODGEPOLE PINE	460	Dahms, 1964

[4]/Transformed version of original equation to solve for SDI.

FIELD PROCEDURES

The purpose of the field measurements is to gather data which will be used to determine average site index and Stand Density Index. Recommended procedures are as follows:

1. Delineate the stand on an aerial photograph.

2. Estimate the number of sample points needed to determine SDI within a sampling error of 10 percent, using experience from similar conditions. Previous timber stand examinations (TSE's) in similar types can be helpful indications of the type of sample variation to expect.

3. Lay out sample points, using a systematic grid.

4. Determine fixed radius plot size.

5. Determine basal area factor (BAF) for variable plot sample. BAF should be selected to give about five to eight trees per point.

6. At each point record routine stand examination information, using Region 6 Timber Stand Examination procedures. Diameter increment should be recorded on a subsample of each point, boring trees which represent a range of diameters, species and crown positions. Although diameter increment is not part of the SDI determination, it is a useful statistic for evaluating whether the stand is fully stocked. At least three site trees should also be measured in each stand. Seedlings are not included in the computation of SDI, and they should not be tallied unless the information is needed for other purposes. If tallied, they should be subtracted from total tree count when determining SDI.

7. It will frequently be necessary to reconstruct past stand conditions where there has been past cutting. This can be done by counting stumps as marked trees in the stand examination procedure. This is done by assigning them a tree history of "5" if they are less than 10 inches in diameter and cut within the last 10 years, or if they are larger than 10 inches and cut within the last 20 years. DBH should be considered equal to the stump diameter inside bark.

It should be noted that these field techniques are no different from sampling procedures used during timber stand examinations. If the routine timber stand examination is not used, any standard timber sampling approach can be utilized to obtain the three basic statistics: Site index, mean stand diameter, and trees per acre.

There are several advantages to using the standard TSE procedures: (1)The techniques are already described in handbooks and field instructions. (2)The field data can readily be collected by technicians skilled in basic forestry measurement, or by contractors with similar capabilities. (3)The stand statistics are computed by a standard computer program and displayed in a series of tables. (4)The stand examination computer printout provides a permanent record which can be used for further analysis as well as a record for the Forest Planning process.

CALCULATIONS

Once the field data have been gathered, the timber stand examination should be processed. The TSE computer printout will include:

STATISTIC	SAMPLE VALUES (example)[5]
site index	68 (ponderosa pine)
species composition	85% ponderosa pine
trees per acre	184 [6]
stand diameter	11.7 inches [6]

From this point, the calculation of SDI and potential productivity are straightforward.

1. SDI. The formula version should be used in most cases for precision as well as ease of calculation. Programmable calculators have been effectively used to short-cut this process. However, the generalized graph (Daniel et al, 1979a) can also be used for appropriate species.

In this example, the ponderosa pine equation is used to calculate SDI:

$$SDI = 10^{(\log N + 1.80 \log D - 1.80)} \qquad \text{(Equation 3)}$$

$$SDI = 10^{(\log 184 + 1.80 \log 11.7 - 1.80)}$$

$$SDI = 244$$

Noncommercial species such as juniper should usually not be used to determine SDI, except in situations where local ecological information indicates that commercial species can be substituted.

2. Productivity. These calculations are based on the assumption that productivity is proportional to site stockability for a given site index. The relationship is shown mathematically as:

$$P_a = P_n \, (SDI_a/SDI_n) \qquad \text{(Equation 4)}$$

where P_a = productivity of the actual stand
P_n = productivity of a normal stand of the same site index
SDI_a = Stand Density Index of the actual stand
and SDI_n = Stand Density Index of the normal stand

SDI of the actual stand has already been calculated, and normal SDI is known. P_n, the productivity of a normal stand, is calculated from the Teply-Berger MAI equations (Equation 4, p.2, Appendix A), using the stand site index, 68 (ponderosa pine). (Note that P_n is equivalent to MAI, cubic feet per acre per year, mean annual increment at culmination.)

[5] These sample values are obtainable directly from the Region 6 timber stand examination computer printout.
[6] Includes trees from both fixed and variable plots; does not include seedlings.

a. Calculate P_n, productivity of a normal stand.

$$P_n = 2.305357 + (0.033890056 * SI) + (0.0090108543 * SI * SI)$$

$$P_n = 2.305357 + (0.033890056 * 68) + (0.0090108543 * 68 * 68)$$

P_n = 46.3 cu.ft. per acre per year

b. Calculate P_a, productivity of the actual stand.

$$P_a = P_n (SDI_a/SDI_n) \qquad \text{(Equation 4)}$$

$$P_a = 46.3 (244 / 370)$$

P_a = 30 cu.ft. per acre per year.

A modification of these steps is included in the sample stand productivity worksheet (Appendix B). This form has been useful for evaluating stand mapping.

FOLLOW-UP. Collection of field data is fairly routine with the process described in this paper. Calculations are also straightforward. But since forests are complex and variable, it will be necessary to carefully evaluate the data in the light of local knowledge and professional expertise.

In situations where results are questionable, it is suggested that an ecologist or certified silviculturist familiar with the local conditions visit the stands with data in-hand. In these situations, the on-the-ground expert is best able to make the determination of productivity, considering both the quantitative stand information and qualitative site and ecological factors.

It should be remembered that the SDI technique was developed to estimate the potential productivity of stands where stockability is limiting. Until more experience is gained, it should not be used to estimate productivity under other conditions.

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APPENDIX H

MEAN ANNUAL INCREMENT EQUATIONS

USED IN SDI PRODUCTIVITY ESTIMATES

December 1971

MEAN ANNUAL INCREMENT EQUATIONS

by

John Teply

John Berger

INTRODUCTION

The following mean annual increment equations (MAI) were developed from normal yield tables to increase the efficiency of survey data compilation. Previously, these values were looked up and interpolated from sources such as the memorandum from H.R. Josephson, November 16, 1962.

By using the developed equations, one can calculate the expected MAI for any determined site index. This is important to forest survey, since any site that is not capable of producing 20 cubic feet per acre per year must be classified as noncommercial forest land.

These equations were developed with the advice and help of mensurationists Robert Pope and C.D. MacLean.

EASTERN OREGON SPECIES

(Blue Mtn. Inv. Unit)

M.A.I. Equations

EQ No.	Spp.	
1	W. hemlock	(263)
	Subalpine fir	(019)
	W. Redcedar	(242)
	Mtn. Hemlock	(264)
	Sitka spruce	(098)
2	Lodgepole pine	(108)
3	W. white pine	(119)
4	Ponderosa pine	(122)
	Jeffrey pine	(116)
	Sugar pine	(117)
5	Douglas-fir	(202)
6	Larch	(073)
7	Engelmann spruce	(093)
8	Red alder	(351)
	All hardwood	
9	White fir	(015)
	Grand fir	(107)
10	Redwood	
	(young-growth)	(213)
	(old-growth)	(211)

EQ No. 1

W. hemlock	(263)
Mtn. hemlock	(264)
Subalpine fir	(019)
W. redcedar	(242)
Sitka spruce	(098)

M.A.I. = -63.689706 + (1.9402941 * S.I.)

(S.I. < 33, MAI = 0) 1/

1/ When the S.I. is less than some specified value, this implies that the computed MAI value goes negative or the function starts curving back up. For either case, we set the MAI equal to zero for program usage.

(At S.I. = 44, MAI = 21.68; at S.I. = 43, MAI = 19.74) 2/

EQ. No. 2

Lodgepole pine (108)

MAI = -12.0388 + (1.18672 * S.I.)

(S.I. < 11, MAI = 0) 1/

(At S.I. = 27, MAI = 20.003; at S.I. = 26, MAI = 18.81) 2/

EQ No. 3

W. white pine (119)

MAI = 5.972615 + (1.857675 * S.I.)

(At S.I. = 8, MAI = 20.83; at S.I. = 7, MAI = 18.97) 2/

EQ No. 4

Ponderosa pine	(122)
Jeffrey pine	(116)
Sugar pine	(117)

MAI = 2.305357 + (0.033890056 * S.I.) + (0.0090108543 * SI * SI)

(At S.I. = 43, MAI = 20.42; at S.I. = 42, MAI = 19.62) 2/

EQ No. 5

Douglas-fir (202)

MAI = -10.303313 + (.032929911 * SI) + (.012207163 * SI * SI) +

(-.00003543129 * SI * SI * SI)

(SI < 29, MAI = 0) 1/

(At S.I. = 53, MAI = 20.45; at S.I. = 52, MAI = 19.43) 2/

2/Forest land is classified noncommercial forest land (NCFL) if it does not produce 20 cubic feet per acre per year.

EQ No. 6

Larch (073)

MAI = -6.0892857 + (.45178571 * SI) + (.014464286 * SI * SI)

(SI < 11, MAI = 0) 1/

(At SI = 30, MAI = 20.48; at SI = 29, MAI = 19.17)

EQ No. 7

Engelmann spruce (093)

MAI = -18.4 + (1.92 * SI)

(SI < 10, MAI = 0) 1/

EQ No. 8

Red alder (351)
All hardwood

MAI = -53.892857 + (1.7178571 * SI)

(SI < 32, MAI = 0) 1/

(At S.I. = 44, MAI = 21.69; at S.I. = 43, MAI = 19.97) 2/

EQ No. 9

White fir (015)
Grand fir (017)

$$MAI = -4.89001 + 311.29546 * \left[\frac{e^{\frac{\left(\frac{SI}{170} - 1\right)^3}{.343}} - .055}{.95} \right]$$

(SI < 6, MAI = 0) 1/

(At S.I. = 20, MAI = 21.31; at S.I. = 19, MAI = 19.56) 2/

(Equation No. 9 developed by C.D. MacLean, PNW Forest & Range Exp. Sta., 1971)

EQ No. 10

Redwood
(young-growth) (213)
(old-growth) (211)

MAI = 157.94643 - (1.78125 * S.I.)
+ (.014330357 * S.I. * S.I.)

(S.I. < 62, MAI = 0) 1/

References for Mean Annual Increment (MAI) Equations

EQ No. 1 (W. Hemlock, subalpine fir, W. redcedar, Mtn. Hemlock, 100-year base)

Western Hemlock. Barnes, George H. 1961. Yield of even-aged stands of western hemlock. USDA Technical Bulletin No. 1273. PNW Forest Experiment Station (Table 12, page 18)

Data adjusted: adjusted to 5-inch standard[4] using stock table from Bulletin 544 and extrapolating to S.I. 60 using Alaska data as guide. (Tech. Bull. 1273)

S.I.[3]	Yield
60	50
70	69
80	90
90	110
100	132
110	152
120	172
130	193
140	210
150	230
160	247
170	265
180	284
190	302
200	322
210	344

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[3] The SI and yield values are the values used to obtain the expressed equation.

[4] To adjust a table of volumes from all trees to trees 5.0 inches and larger, first look up the average diameter for a particular age for the stand. Second, find the table for percentage distribution of volume. Using the average diameter, determine the percent of stand volume that is less than 5.0 inches by summing the volume percent for that average diameter class less than 5.0 inches and half of the 5.0 inch class. This percent volume should then be deducted from the volume yield for that age and site index.

Example: Ponderosa pine; yield of even-aged stands. Tech. Bull. No. 630.

1) Page 14, Table 5. Average diameter for Age 60, S.I. 40, is 3.0 inches.
2) Page 14, Table 6. Cubic volume/acre for Age 60, S.I. 40, is 1,800.
3) Page 44, Table 30. Average diameter of 3 inches. Percent volume in stand less than 5.0 inches is 35 percent, +32 percent (∵ dia. classes are 3.5-4.5 inches, 4.5-5.5 inches)
4) Reduce 1800 cu. ft./ac. by 67 percent. The remaining volume is the volume/acre for trees 5.0 inches and larger at age 60 and S.I. 40.

EQ No. 2 (Lodgepole pine, 50-year base)

Lodgepole pine, Dahms, Walter G. 1964. Gross and net yield tables for lodgepole pine. U.S. Forest Service Res. Paper PNW-8. PNW Experiment Station.

No alterations in data.

S.I.[3/]	Yield
30	23
40	35
50	47
60	59
70	71

EQ No. 3 (Western white pine, 50-year base)

Western white pine. Haig, I.T. 1932. Second-growth yield, stand and volume tables for the western white pine type. USDA Tech. Bull. 323.

Data altered to a 50-year base.

S.I.[3/]	Yield
30	62
35	71
41	80
46	90
51	100
56	110
61	120
66	128
71	137
76	146
81	155

EQ No. 4 (Ponderosa pine, jeffrey pine, sugar pine)

Ponderosa pine. Meyer, W.H. 1938. Yield of even-aged stands of ponderosa pine. USDA Tech. Bull. 630.

Data altered: Changed low site values to agree with Lynch, D.W. (Res. Paper No. 56) and adjusted to 5-inch standard.

S.I.[3/]	Yield
50	26
60	34
70	46
80	59
90	78
100	97
110	118
120	138
130	163
140	186
150	209
160	234

EQ No. 5 (Douglas-fir, 100-year base)

Douglas-fir. McArdle, R.E., Meyer, W.H., and Bruce, D. 1930. Rev. 1949. The yield of Douglas-fir in the Pacific Northwest. USDA Tech. Bull. 201

Data altered: Added first two values on lower end of curve. (Added values to force curve for reasonableness.)

S.I.[3/]	Yield
30	0
70	42
80	54
90	65
100	78
110	91
120	107
130	123
140	138
150	151
160	163
170	174
180	184
190	193
200	201
210	207

EQ No. 6 (Larch)

Larch: Letter from Jim Brickell. Forest Service INT Moscow, July 3, 1968.

Data altered: Plotted Brickell's equation.
(MAI = -126.05 + (2.7974081 * SI) + (1919.3157/SI)) and extrapolated data through zero yield.

S.I.	Yield
10	0
20	9
30	20
40	35
50	52
60	74
70	97
80	122

EQ No. 7 (Engelmann Spruce)

Engelmann Spruce: Letter from Jim Brickell. Forest Service INT Moscow, July 3, 1968.

Data altered: Straight line approximation half way between Western white pine and Western larch.

S.I.	Yield
20	20
70	116

EQ No. 8 (Red alder, All hardwood, 50-year base)

Red alder. Worthington, N.P., Johnson, F.A., Stoebler, G.R. and Lloyd, W.S. 1960. Normal yield tables for red alder. PNW Experiment Station Paper 36.

No data alterations.

S.I.[3/]	Yield
50	26
60	34
70	46
80	59
90	78
100	97
110	118
120	138
130	163
140	186

EQ No. 9 (White fir, Grand fir, 50-year base)

White fir. Schumacher, F.X. 1926. Yield stand and volume tables for white fir in the California pine region. University of California, Berkeley, Bull. 407.

Data altered: Adjusted stand table to eliminate trees 3.5-4.9 inches d.b.h.

Data was then curved and using the method described by Jensen and Homeyer (INT Mtn. Sta.) developed the equation. (Matcha Curve - 1 for Algebraic Transforms to Describe Sigmoid- or Bell-shaped Curves, by C.E. Jensen, J.W. Homeyer. INT Experiment Station, 1970)

S.I.3/	Yield
30	41
40	59
50	88
60	127
70	162
80	195
90	216

EQ No. 10 (Redwood)

Redwood. Lindquist, James L., Palley, Marshall N. 1963. Empirical yield tables for young-growth redwood. Calif. Agr. Exp. Sta. Bull. 796

Data altered: Table 8, page 21 ofBulletin 796 showed a culmination of yield for site indices 180-240. There was no culmination indicated for site indices 100-160. For this reason, I graph each MAI over age for each site index. I then extrapolated each graph to a culmination.

S.I.	Yield
100	123
120	149
140	193
160	239
180	300
200	375
220	460
240	556

APPENDIX I

FIELD FORM FOR PLANT ASSOCIATION IDENTIFICATION

DATE __/__/__ T__ __ N R__ __ E SEC__ __

COMPARTMENT ______ CELL ___ OBSERVER ____________

DISTRICT ______ GENERAL LOCATION ______________

____

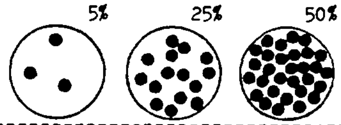
ELEVATION ______FT. SLOPE ______% ASPECT ______

POSITION:
1-Ridge
2-Upper 1/3
3-Mid slope
4-Lower 1/3
5-Bench or flat
6-Valley bottom

SLOPE CONFIGURATION:
1-Convex
2-Straight (flat)
3-Concave

% CROWN COVER: 1% = few plants

5% 25% 50%



TREES: Scientific name	Code	Common name	%COVER OS	%COVER US
1 Abies amabilis	ABAM	silver fir	__	__
2 Abies lasiocarpa	ABLA2	subalpine fir	__	__
3 Larix lyallii	LALY	subalpine larch	__	__
4 Larix occidentalis	LAOC	western larch	__	__
5 Picea engelmannii	PIEN	Engelmann spruce	__	__
6 Pinus albicaulis	PIAL	whitebark pine	__	__
7 Pinus contorta	PICO	lodgepole pine	__	__
8 Pinus ponderosa	PIPO	ponderosa pine	__	__
9 Populus tremuloides	POTR	quaking aspen	__	__
10 Pseudotsuga menziesii	PSME	Douglas-fir	__	__
11 Tsuga mertensiana	TSME	mountain hemlock	__	__

SHRUBS AND SUBSHRUBS

1 Arctostaphylos uva-ursi	ARUV	bearberry	__
2 Ledum glandulosum	LEGL	Labrador tea	__
3 Linnaea borealis var. longiflora	LIBOL	twinflower	__
4 Pachistima mysinites	PAMY	pachistima	__
5 Phyllodoce empetriformis	PHEM	red mountainheath	__
6 Physocarpus malvaceus	PHMA	ninebark	__
7 Purshia tridentata	PUTR	bitterbrush	__
8 Rhodendron albiflorum	RHAL	Cascades azalea	__
9 Symphoricarpos albus	SYAL	snowberry	__
10 Symphoricarpos oreophilus	SYOR	mountain snowberry	__
11 Vaccinium caespitosum	VACA	dwarf huckleberrry	__
12 Vaccinium membranaceum	VAME	big huckleberry	__
13 Vaccinium myrtillus	VAMY	low huckleberry	__
14 Vaccinium scoparium	VASC	grouse huckleberry	__

PERENNIAL HERBS

1. Agropyron spicatum var. inerme	AGIN	awnless bluebunch wheatgrass	__
2. Arnica cordifolia	ARCO	heartleaf arnica	__
3. Calamagrostis rubescens	CARU	pinegrass	__
4. Equisetum arvense	EQAR	common horsetail	__

ADDITIONAL SPECIES OR OBSERVATIONS

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